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QUARTERLY

OF THE

National Fire Protection Association

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40 CENTRAL STREET, BOSTON, MASS.

National Fire Protection Association

INTERNATIONAL

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Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Insurance Bureau.
Western Sprinklered Risk Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.

Over 4,200 Associate Members

Table of Contents.

FULL SCALE FIRE TEST, U. S. BUREAU OF STANDARDS ..... FRONTISPIECE

EDITORIALS 5

MEETINGS OF EXECUTIVE COMMITTEE 16

FIGHTING FIRES BEFOREHAND. *C. W. Mowry* 19

THE 1927 FIRE LOSS 30

ANNUAL FIRE LOSSES IN THE U. S. FOR FIFTY-THREE YEARS 33

CANADIAN FIRE LOSSES, 1927 34

WEST PLAINS GARAGE AND DANCE HALL DISASTER 36

CONTROL OF ELECTRICAL EQUIPMENT SALES IN THE CITY OF PORTLAND, OREGON. *F. D. Weber* 38

ANOTHER "FIREPROOF" SCHOOL BURNS 42

TESTS OF THE SEVERITY OF BUILDING FIRES. *S. H. Ingberg* 43

FIRE TEST OF BRICK-JOISTED BUILDINGS 62

STUDYING AIRPLANE FIRES 70

TWO INTERESTING WOOD SHINGLE ROOF FIRES 85

WORCESTER, MASS. 85

EAST CONCORD, N. H. 87

ALEXANDER INDUSTRIES FIRE, ENGLEWOOD, COLORADO 89

CRISFIELD, MD., CONFLAGRATION. *Underwriters Association of the Middle Department* 93

FIRE RECORD OF FUEL OIL BURNERS 96

HEAT AND POWER INSTALLATIONS 97

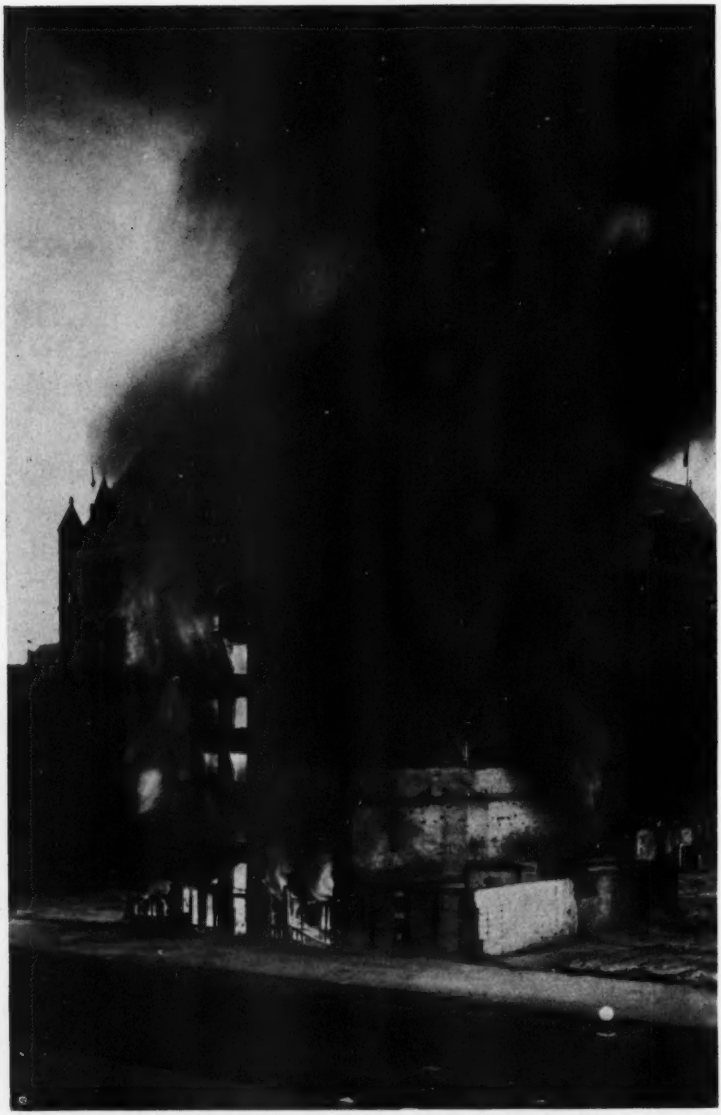
PROCESS HEATERS 106

DETAILS AND CLASSIFICATION OF CAUSES, INDUSTRIAL AND MERCANTILE OCCUPANCY FIRES 113

DOMESTIC OIL BURNERS 119

FIRES IN WHICH THERE WAS LOSS OF LIFE 122

Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.



A full scale fire test was conducted by the U. S. Bureau of Standards in Washington, D. C., on June 17, when two brick joisted buildings were ignited and allowed to burn without the application of water. (See article on page 62.)

The Quarterly

Vol. 22 July, 1928 No. 1

Thirty-second Annual Meeting. The publication of this issue of the *Quarterly* as of July, 1928, in its usual form is the result of the action of the Association at the thirty-second annual meeting in voting by a considerable majority to postpone to the next annual meeting consideration of the recommendations made by the Committee on Articles of Association. The value of the proposed conversion of the *Quarterly* into a monthly publication was not discussed, the action turning upon the point of the dues-increase and the feeling that more time should be allowed for consideration of the various items of the report. (See Proceedings, pp. 30-49.) The conversion of the *Quarterly* being predicated upon the proposed dues-increase, it will appear as usual during the current Association year, supplemented as formerly by special reports where necessary for the information of members.

The attendance at the annual meeting was normal and the large budget of technical reports was disposed of in the usual competent fashion, as may be noted by a review of the *Proceedings*. The high lights in the committee items were Mr. Small's admirable presentation of the accomplishments of the Electrical Committee, and the first report of the new committee on Visual Education, so interestingly presented by its chairman Mr. Vernor. Mr. Newell also came in for well-deserved praise for his advancement of the work of the Committees on Gases and Garages, and his completion of the brochure on Paint Spraying, a timely task into which he had put an exceptional amount of painstaking labor. The addresses by Mr. Mowry and Mr. Ingberg were of the quality to be expected from these able and expert members of the Association.

The first official session of the Chamber of Commerce and Safety Council Section registered the highest point of enthusiasm during the convention. Although getting under way late in the Association year, and somewhat hampered by the meeting of the National Chamber of Commerce occurring on the same days as our own, there were present representatives of practically all of the Chambers which have made exceptional progress in fire prevention work, and the quality of the speaking was a voucher that the new Section already has a vitality that will make it a factor in the Association's future life and developments.

It was a hard-working convention as our meetings usually are, and the bad weather of the third day, on which the hose cart coupling frolic had been planned, drove us inside for an extra business session. There was in consequence little relief from the serious matter of the program. "How do you ever get 'em to work like this?" asked a Chamber of Commerce executive who was attending for the first time. "Oh," said the president, with an 'I've eaten the canary' smile (and who had steamer tickets in his pocket for a two months' loaf in Europe), "they don't work so hard."

* * * * *

A Friendly Voice. Quaint and beloved Charles Lamb, writing from England a half century ago in the days of sailing ships to a friend in New South Wales, said "and how do I know but what I write you today as truth may, before you receive it, most unaccountably turn into a lie?" So even in the accelerated time of a month which is now required for a letter from Sydney to reach Boston, ideas expressed at the beginning of the period may, before the end of it, turn out to be unrealized. The following letter was received on June 5th by President Pierce from Mr. A. H. Minchin, our member in New South Wales:

FIRE UNDERWRITERS' ASSOCIATION OF NEW SOUTH WALES
The Royal Exchange, Bridge St.,
Sydney, 2nd May, 1928.

Dana Pierce, Esq., President,
National Fire Protection Association.

Dear Sir:

I was very pleased to note from your advices of March 20th that the *Quarterly Magazine* is to be reorganized and issued Monthly.

This Periodical has proved a most valuable adjunct to my Library, and one which I never fail to consult when considering necessary revisions to our Classification of Risks.

As to the question of increase in annual dues, the fact that the many publications issued and the resources placed at the disposal of Members has been obtainable hitherto at such an extremely low charge, has ever been a source of amazement to me and others who have benefited by the activities of your Association.

As one of the Members mentioned in the last paragraph of your Circular letter who cannot come to Atlantic City, I must take this opportunity of stating that the services rendered by the Secretary and his Staff during my five years Membership have been all that the most exacting Member could desire, and the information so cheerfully furnished on all occasions has always been sufficient to meet my needs.

If any more comprehensive statement were possible to express my appreciation of the N.F.P.A. I would cheerfully use it, but I wish it to be understood that to me the N.F.P.A. leaves nothing to be desired.

With very kind regards and greetings from Australia, I am

Yours faithfully,

(Signed) A. H. MINCHIN, Chief Surveyor.

This is certainly as gracious as a letter from a member could be. It is a comfort to know that even with our present office facilities we are able to serve such appreciative members as we have on the other side of the world.

Advertising in the *Quarterly*. The bulletin of the Executive Office announcing acceptance of advertising in the *Quarterly* beginning with the October issue may evoke mixed emotions in certain members, particularly those who do not like innovations. The members of the N.F.P.A. have always taken their Association very seriously. While this is of course one of the secrets of the Association's strength and influence, it sometimes makes rapid progress difficult. When the idea of converting the *Quarterly* into a monthly was discussed, a member wrote imploring us not to do it. These were his reasons: he habitually read every issue from cover to cover, some of the articles twice; he bound each volume and oftentimes reread portions of them; a monthly with an equal amount of good stuff in it would upset his reading habits; he would be forced to lay aside certain issues incompletely read. Besides this he didn't believe any human agency could keep a monthly up to the high standard the members have come to expect of the *Quarterly*.

An answer might be that the reading of the *Quarterly* should not be made a moral problem. Some articles in it are of especial value to one, and not so valuable, perhaps, to another. Proper filing and indexing make the contents available at later dates whenever special interest in any given subject awakens or revives. With many busy members the question is not so much to read every article as to know where to find it when wanted. The editors who have made the *Quarterly* for so many years as good as time, labor and limited resources would permit, find their best tribute to its usefulness in the fact that the various issues are so soon exhausted. A rain of orders for extra copies follows certain issues, and new members seeing the *Quarterly* for the first time and recognizing the mine of information it contains always want back numbers and frequently the entire file. One of our enforced economies is the avoidance of excess printing and storage. The result is a continuous correspondence in the purchase of our publications from members willing to sell for members wishing to buy.

The reaction to the advertising idea so far expressed is wholly favorable except for one esthetic objection. A member states that it is refreshing to have a magazine without advertising. Besides this, one has expressed the apprehension that advertisements of substandard devices or materials may get in. Neither of these objections would seem valid. We shall assemble our advertising pages back and front. Members will not be compelled to pursue ribbons of text through cañons of advertising. The *National Geographic* represents our idea. As to undesirable or misleading advertisements, the Executive Office will accept full responsibility for the character of the advertising, and no member need fear that any device or material that is not satisfactorily vouched for by dependable agencies will see the light in any N.F.P.A. publication.

As to the value of the *Quarterly* as an advertising agency, this matter has been reviewed by an expert specializing in trade and technical publications and pronounced a unique and valuable medium for reaching an exceptionally high grade clientele. For a number of years influential members have urged the editors to open the *Quarterly* to advertising, pointing out that the American Society of Mechanical Engineers, the American Society of Testing Materials, the American Water Works Association and similar societies habitually grant this privilege to their members, while members of the N.F.P.A. can reach one another only by the wasteful process of circularizing the addresses in the year book. The acceptance of advertising in our *Quarterly* will, it is believed, provide a legitimate and profitable source of revenue, permitting improvements in the magazine itself and a more complete general Association service.

* * * * *

Mr. Hoover Knows. We hope we shall not invite the charge of political partisanship in expressing gratification at the nomination by the G. O. P. for president of a man who knows something about our Association and what it is trying to do. When our secretary was conferring in the spring of 1927 with the Internal Revenue Department of the U. S. in the hope of securing the ruling (which he did) that anybody making gifts to our field engineering service might deduct the amount from his income tax return, he also wrote Mr. Hoover describing this service to him. Mr. Hoover's reply, which we are now extracting from our files, is characteristic:

DEPARTMENT OF COMMERCE
Office of the Secretary
WASHINGTON March 3, 1927.

Dear Mr. Wentworth:

I have your letter informing me of plans of the National Fire Protection Association to aid and encourage fire prevention work by local committees.

Our annual fire waste of several hundred million dollars is capable of great reduction at a total cost to the community low in relation to the benefits secured. The problem resolves itself largely into the individual problems of local communities throughout the country; the efficacy of community campaigns to reduce fire losses has been amply demonstrated in many American cities. Coöperation of all different elements in the community is required for the best results, and for that reason I believe that the local committees sponsoring the work should be thoroughly representative. Their analysis of local problems can be made easier and their work made more effective with the aid of experts who have had experience elsewhere and are familiar with the standards and methods worked out by national groups on the basis of scientific tests and practical experience.

Your association by making competent expert assistance more readily available could give substantial aid to cities which desire to reduce their fire wastes, and I hope that your program of work may be successful in stimulating and serving local initiative in this field.

Yours faithfully,

(Signed) Herbert Hoover.

That this field work, now entering its fifth year, has been successful in focusing our own influence and that of the organizations coöperating with us

upon the logical points of attack, the cities themselves, may be indicated by the reduced fire loss of 1927 and the favorable statistics, so far, of 1928. Our engineers have made 500 visits to 130 cities, with varying degrees of accomplishment in practically all. A dozen cities with fire records outstandingly bad in 1924, when we began work in them, show a steady and most gratifying improvement for every year since, during which time we have kept in active communication, stimulating, encouraging and commending the agencies our engineers were originally instrumental in awakening. Should Mr. Hoover be president when we make our plea in 1929 for the usual fire prevention week proclamation we shall hope to recall to his mind his generous letter of 1927 and exhibit some interesting statistics along with it.

* * * * *

Children Prefer Firecrackers. The *New York Herald-Tribune,* vehicle of enlightened opinion, outlines in its issue of July 2nd its attitude toward the widespread effort of parents to protect child life against death and injury from fireworks. Following is its editorial:

Children Prefer Firecrackers.

No longer can it be urged against firecrackers that they frighten horses and cause disastrous runaways. A motor car with the muffler cut out makes more noise than fifteen bunches of firecrackers touched off at one time. Perhaps within the city limits the red-coated explosives are dangerous. But in the suburbs they may be shot off without peril, if a grown-up is by to prevent such experiments as allowing them to explode while still held in adolescent fingers. The effort to reduce the celebration of the nation's greatest holiday to flag raisings and patriotic orations will never succeed as long as there is a younger generation. Children prefer firecrackers.

It is wise, of course, to exercise parental supervision while the noisemakers are expressing the sentiments of the youth of the land. But to forbid them would have the same effect as a prohibition imposed on rural youth against going swimming or eating green apples. The firecracker is obtrusively noisy. To watch the fuse burn down to the red cylinder and to hold the breath till the delicious moment of the detonation brings a pleasure that few other things afford to a youthful American. The racket may be distasteful to adult ears, yet it is seldom that in a family party engaged in observing the Fourth the father and mother do not light as many crackers as do the children.

Without firecrackers by day and fireworks at night the Fourth would be meaningless to a generation which has no time to spend listening to local elocutionists recite the Declaration of Independence. Very young people like noise and plenty of it. Their desire to produce it is rigorously suppressed for 364 days in the year. They certainly ought to have a special privilege on the 365th, provided care is taken to see that they do nothing more serious than burn their fingers.

It is unnecessary to point out the ineptitude of this. To play with firecrackers is to play with fire! To play with fire at any time, anywhere, is to

invite death to the young. Within the month parents of dead and blind children in Detroit and Rochester have appeared before hearings which resulted in the prohibition of the private use of fireworks in those cities. Those children are just as dead and just as blind whether the accidents which were the causes of their agonies occurred within the city limits or in the suburbs. Neither the dead nor the blind will ever read the comforting assurance of the *Herald-Tribune* that if their parents had watched them they might merely have burned their fingers.

* * * * *

Fireworks in Detroit. The chairman of the Fire Prevention Committee of the Detroit Board of Commerce, Mr. Paxton Mendelssohn, is one of the few young men of America who having the privilege of leisure accepts it as a responsibility. His generosity in personally providing special equipment for the Detroit fire department is already a matter of public record, but his continuous application of time and intelligence to the general fire safety of his city is not so well known outside of Detroit.

Chairman Mendelssohn and his associates have recently demonstrated the truth of the old saying that there are other ways to kill a cat than by hanging. We are taking the liberty of quoting from one of his recent letters which tells the story of how Detroit managed to safeguard the lives of its children.

Your Association already knows that we have recently had a considerable struggle relative to our Fireworks Ordinance. In 1926, when certain types of fireworks were still permitted, we had seven deaths on the Fourth of July attributable to fireworks, all being children under the age of eleven. In the same year we had sixty-eight more or less serious injuries and some seventy odd fires caused by fireworks. The situation being so serious, various efforts in which our Committee was included resulted in Councilman Callahan introducing an absolutely prohibitive ordinance which was passed unanimously by the Council. The result was that in 1927 we had no deaths from fireworks, only three or four very minor fires, and only a very few minor injuries.

However, the fireworks dealers discovered that our ordinance was contrary to State law, inasmuch as Michigan has a State law which legalizes certain types of fireworks, and, therefore, we as a city in the state had no right to entirely prohibit fireworks. Our ordinance was declared invalid and thrown out. One of our assistant corporation counsels drew up a new ordinance, which coincided with the State law by permitting the sale of some types of fireworks as the State law allowed, but surrounding the sale and use of these fireworks with sufficient regulations, such as license fees of considerable amount, records to be kept of individual sales, restrictions regarding the discharge of fireworks on a public street or highway, or within fifty feet of any dwelling. In summing up the situation, this ordinance, while permitting the sale of certain kinds of fireworks, makes it practically impossible to use them after they are sold. This ordinance was submitted to the Council and immediately the fireworks dealers submitted a substitute ordinance which was practically a duplicate of the State law, and it resolved itself into which one of these two ordinances would become effective.

A hearing was set for Monday, May 7, which was, as you know, the first day of your convention, and on which day practically all the persons interested in the fireworks ordi-

nance would be out of the city. I discovered this by accident and succeeded in having the hearing set a week later, May 14, when we all would be back. We marshaled our forces and on Monday, May 14, had over fifty representatives of our women's organizations at the City Hall. We had a considerable representation of our Fire Prevention Committee, and many others interested in the safety of life and property, including the Fire Marshal. The fireworks dealers were represented one hundred per cent. We all had our say, the fireworks dealers pleading their right as business men to do business, stating that they had eliminated all the hazardous fireworks, our representatives pleading life and children-saving. The hearing adjourned, the Council taking the matter under advisement. I am pleased to report that last night at our regular weekly Council meeting, the influence of the various speeches made against fireworks bore fruit, for our Council, without a dissenting vote, rejected the ordinance proposed by the fireworks dealers and adopted the highly restrictive ordinance proposed by our corporation counsel and sponsored by Councilman Callahan, our various safety organizations, and the women of Detroit.

There is no doubt that a way may be found in every city to abolish the orgies of fire and noise which would long since have become a memory were they not kept alive by a commercial interest. A plea for the privilege of selling something that every year demonstrates will poison, maim, blind and kill the children of the country can have no standing before modern intelligent public opinion. It merely needs to be awakened by such men as Mr. Mendelssohn of Detroit and Mr. A. L. Armstrong of the Kodak Company, who recently accomplished a similar result in Rochester.

* * * * *

Incendiarism and Arson. While a number of our influential members have actively participated during the past two years in our efforts to secure the passage of the model arson law of our Fire Marshals Section, now essentially in effect in fourteen states, not many are aware of the activity of the committee on incendiarism and arson of our member, the National Board of Fire Underwriters, which not only aids public prosecutors in securing evidence and otherwise making their cases effective, but keeps economic conditions under review, anticipating as far as possible the so-called "business" fires which seem to follow decline of activity in different industries. The report of this important committee to the annual meeting of the National Board says:

An analysis of Government reports shows that there has been much unemployment throughout the country. Reports published as of November, 1927, show a falling-off in payrolls of the hosiery and knit-goods trade, the balance being on the minus side of the ledger. There was a similar decline of more than 17 per cent in the furniture, silk-goods and men's clothing trades. The lumber and mill trade has also been seriously affected in like manner, as well as foundry and machine shop products, to say nothing of the iron and steel trade, which is supposed to be flourishing, but has had a falling-off of 16 per cent in its payrolls.

In the bankruptcy courts there is much congestion, and a large number of failures are occurring throughout the country, and have occurred steadily during the past year. Many bankruptcies take place where the failures are "safer" than fires, and these bankruptcy figures as well as the unemployment situation bear a very direct relation to the fire loss.

However, the number of prosecutions for arson throughout the country indicate that it is becoming safer and easier to resort to the bankruptcy court for redress of business failures, than to the "torch" of the incendiary. There were a number of incendiary fires in the trades mentioned, but prompt investigation defeated, in many instances, the intent of the perpetrators. The unusual interest shown by local authorities in the suppression of arson, in our judgment, has much to do with the decrease in "business fires," and this class of incendiarism has diminished.

For many years an impression seems to have prevailed among police authorities that fire insurance companies were reluctant to take an active interest in the suppression of arson, and failed to coöperate with public authorities in the investigation of incendiary fires and the prosecution of those responsible for them. Furthermore, it was alleged, in some cases, to be almost impossible to obtain from insurance companies essential information relative to insurance, proofs of loss, and other details required to bring about conviction in a court of law, or to show convincing motives for the crime. But gradually this erroneous impression is being dispelled. This committee, through its special agents, coöperates with the local authorities, and functions as a definite contact between them and the fire insurance companies.

As the representatives of this committee become more widely known, a larger volume of accurate information automatically reaches them concerning anticipated or projected fires, for the purpose of collecting insurance. Our representatives have been able to prevent a very large number of such losses.

During the past year several cases of anticipated fires have been reported directly to the National Board offices from chiefs of police in various places, acting on their own initiative. In these cases, a difficult and delicate problem arises as to cancellation of policies as, naturally, this cancellation immediately acquaints the assured with the fact that he is under suspicion. Question arises as to just how far public authorities and special agents can go in this matter of "anticipated fires," and the course to be pursued requires judgment, tact, and decision. Considerable responsibility is involved in permitting a fire to take place when once the plans have been discovered, and such responsibility must be placed directly upon the local public authorities.

The report also cites examples of incendiary activity in a number of cities from which the following notes are selected:

Detroit.

The City of Detroit has, during the past year (1927) shown a marked reduction in the number of incendiary fires. The Detroit Arson Squad has achieved notable success. During the year, 512 fires of suspicious origin, of which 108 were known to be incendiary, were investigated. The apprehension of dangerous pyromaniacs in Detroit was a feature of this year's work, one "pyro" alone having caused fifteen fires, nine in the hotel in which he was staying; and he confessed, after his arrest, to having made eight other fires in one afternoon, four in downtown office buildings in Detroit. This man had come from Ann Arbor, Michigan, and admitted having set fire to the University of Michigan Hospital at Ann Arbor, where he was employed as a porter.

Pittsburgh.

Important work was done in connection with the so-called "arson ring" in this city which, during the past twenty years, had collected large sums of money for incendiary fires. This crowd employed various operatives, not only in Pittsburgh, but in Philadelphia and other near-by cities. Intensive investigation, conducted over a number of months by four special agents of the National Board, was successful in exposing the ramifications of this "gang," with the result that successful prosecutions were carried out and the "ring" broken up.

Waterbury, Conn.

Another remarkable instance of the failure of an incendiary attempt, with loss of three lives, one of whom was a notorious firebug, occurred in this city on February 5, 1928, where a fire developed in a furniture store. This fire caused the death of two children and an unknown man, subsequently identified as Sam Weis, one of the persons suspected of the crime. This man used several aliases and was proved to have been connected with numerous similar crimes in other parts of the country. In one of his pockets was found a key to the burned building and more than $500 in cash. The facts developed by the investigation of this fire indicate the extent to which certain classes of the criminal population will go, and the full record is an almost unbelievable story of criminal depravity.

Westport, Conn.

A somewhat unusual fire, with intent to defraud, occurred at Westport, Conn., on December 18, 1927, and involved the former editor of a newspaper in that place. He set fire to his residence in an attempt to collect $70,000 life insurance and $12,000 fire insurance. In order to carry out his plans, he evolved an elaborate and ingenious alibi, and furthermore, employed a man from the Municipal Lodging House in New York City to act as caretaker on his place, this employment being a "blind" to conceal his crime. Apparently it was the intention to burn the property and then have the body of the caretaker discovered in the ruins and identified as his own, in order to collect life insurance. Fortunately, the proposed victim eluded the trap, the plan to chloroform him having failed. A special agent of the National Board devoted a great deal of attention to this unusual case, with the result that the state's attorney was able to bring the matter to a successful conclusion, the incendiary entering a plea of guilty and being sentenced to from seventeen to twenty-five years in the penitentiary.

These notes illustrate the baffling character of many arson cases and demonstrate the great need for state laws without ambiguous phrases through which such criminals may escape.

* * * * *

The Telephone Company Helps. The American Telephone and Telegraph Company is an annual subscriber to our field engineering service, its president, Mr. Walter S. Gifford, being one of our sponsors. The careful thought the company is giving to fire protection matters was reflected in the behavior of the telephone building in the recent Fall River conflagration, which was terrifically exposed but came through unscathed. Beside the active coöperation of the company's local managers in the work of our field engineers in their attacks on city conflagration hazards, we have the advice and assistance of the plant engineer of the company, Mr. Harry P. Charlesworth.

And now comes along from the New England department of this great public utility a little leaflet printed in red ink which sets out the possibilities and limitations of the use of the telephone in transmitting fire alarms in a fashion unsurpassed to our knowledge in the publications on this subject. Here is the text of it:

Is Your House A-Fire?

We hope not. But the red terror gives no warning. We want to talk things over with you before it strikes.

Fire Department authorities say that the nearest fire-alarm box should be pulled in case of fire; yet it's a good bet right now that *you* don't know where your nearest fire-alarm box is. We'd even wager a big red apple you don't know how to "pull" it.

Isn't the telephone more convenient, you ask? Perhaps—but when in trouble you cannot get too much help.

Use *both* agencies. While you are telephoning, send some one to the fire-alarm box also.

The fire may have burned out your telephone wire. Or, in your excitement, you may not give the necessary details as exactly as the regular alarm system transmits them. And remember, the saving of life may be a matter of only a minute or two.

Where the Telephone Fits

Emergency fire service, like all emergency service, is our contribution to the public good. In hundreds of instances, grateful subscribers generously credit us with saving property—often with saving life. Getting down to brass tacks, however, it is not our business to turn in fire alarms.

Our business is to connect your telephone with any other telephone on demand. When we do more, we go outside our business to do a neighborly act.

We are glad to do it. We are anxious to help. But you must understand that our help can be effective only in proportion to our knowledge of the facts.

Too often the subscriber cannot wait to talk to the Fire Department. Too often panic makes him incapable even of giving our operator all the facts.

"Fire!" Yes; but where? *Who* you are—*where* you are—*what* Fire Department serves you—these things she must know if she is to help.

A Problem Peculiar to Boston

There's one particularly troublesome thing about telephoned fire alarms in Metropolitan Boston. This greater city of ours is all grown together—physically, commercially, socially—but most of its parts keep their municipal identity.

Fire protection is a local job. But many telephones in the edge of one municipality are served by a central office in another.

From such a telephone—and the fact gives both fire authorities and ourselves concern—an emergency call may go to the wrong Fire Department, with consequent delay.

Right now, ask yourself if yours is such a telephone. If it is, fix in your mind, panic-proof, that you must ask for the Fire Department of your own town—by name. This is vital.

In any case, know *what* Fire Department you look to for protection. Write it in large letters on the outside covers of your directories—both of them. The act itself will help fix it in your memory; and there it is in case of need.

Think Ahead

Lots of times it's wise to "stop to think"; but a fire emergency is not one of them. Neither can one always rely on a cool head and a quick wit.

Every member of your family, business or domestic, ought to think ahead—to know what to do in case of fire.

Know where your fire alarm box is located, and how to operate it. One pull at the lever, and the whole story is told. There is fire. It is in a certain district. The alarm has gone to the right place. The motors roar on their way.

Use the telephone, also, but think that out too. Be sure to say "Emergency." Ask for your own Fire Department.

"Emergency! Give me the 'Smithtown' Fire Department" is the best way.

Wait on the line, if you can, and talk with the officer who answers. If the emergency will not permit this, tell our operator. But remember that unless you tell her *exactly where the fire is,* she is sorely handicapped in her effort to help.

In Time of Need

This little preachment is meant to help you in time of need. We stress the fire call; but the suggestion that you think ahead, that you prepare in advance to be cool and calm, definite and exact, applies to police and ambulance calls—in fact to all emergency service.

Our members throughout North America might very well reprint and circulate this most helpful little preachment, which, while breathing the desire of the telephone company to help to the extent of its ability, does not hesitate to point out in no uncertain fashion the need of every community for a complete and dependable municipal fire alarm system, and the regular and habitual use of it.

* * * * *

Electrical Field Practice. Members who are aware of the great popularity and general usefulness of our inspection manual Field Practice will be interested in the project to produce a companion volume, "Electrical Field Practice," which will mean as much to electrical inspectors as the original manual means to fire department and insurance bureau inspectors and everybody else responsible for reducing common fire hazards in properties. The prospective new manual will be of exceptional service in interpreting and illustrating the meaning of the rules in the National Electrical Code. The manual is to be published when ready, in format similar to the general field practice book, and is to be prepared by a committee under the direction of our electrical field engineer, Victor H. Tousley, who is exceptionally qualified for the task as an inspector applying the code for many years in the city of Chicago and an author of several books on electrical subjects.

Meetings of Executive Committee.

May 7, 1928.

MEMBERS PRESENT.

Albert T. Bell, Atlantic City, Chairman
Dana Pierce, Chicago, President
Frank C. Jordan, Indianapolis, Vice-President
Allen M. Schoen, Atlanta, Vice-President
Franklin H. Wentworth, Boston, Secretary-Treasurer

Eugene Arms, Chicago
George W. Booth, New York
C. T. Ingalls, Oklahoma City
H. L. Miner, Wilmington, Del.
F. T. Moses, Providence
S. D. McComb, New York
Sumner Rhoades, New York
P. W. Terry, St. Louis
J. S. Trump, Philadelphia

Business Transacted.

The report of the Chairman of the Executive Committee to the annual meeting was approved.

The report of the Treasurer was approved.

The report of the Committee on Articles of Association was discussed in connection with several communications from members of the Association in relation to the same, and it was voted to reaffirm the action of the Committee at its January meeting in recommending the adoption of the items in the report of the Committee on Articles of Association.

The controversy with the manufacturers of the "Shur-Stop" extinguisher was discussed, and on motion of the Secretary the following committee was appointed for a conference with the manufacturers with full power to act: President Dana Pierce, Chairman, H. L. Miner, F. T. Moses.

June 22, 1928.

MEMBERS PRESENT.

Albert T. Bell, Atlantic City, Chairman
A. M. Schoen, Atlanta, President
F. T. Moses, Providence, Vice-President
R. P. Miller, New York, Past President
Franklin H. Wentworth, Boston, Secretary-Treasurer

Eugene Arms, Chicago
Geo. W. Elliott, Philadelphia
W. F. Hickey, New Haven
C. T. Ingalls, Oklahoma City
W. E. Mallalieu, New York
S. D. McComb, New York
S. L. Nicholson, New York
Sumner Rhoades, New York
J. S. Trump, Philadelphia

A. R. Small, N.F.P.A. representative on American Engineering Standards Committee, was present by invitation.

Business Transacted.

It was voted to hold the 33rd annual meeting May 13, 14, 15, 16, 1929, at Memphis, Tenn. The President, Chairman of Executive Committee, and

Managing Director were appointed as a Program Committee with authority to add to the number.

The Treasurer's budget for 1928-1929 was amended and approved.

W. F. Hickey of New Haven and C. T. Ingalls of Oklahoma City were selected to complete the Nominating Committee for 1929.

Franklin H. Wentworth, Geo. W. Elliott and S. L. Nicholson were appointed a committee to report to the Executive Committee at its next meeting a form of by-laws and other details of procedure for incorporating the Association.

An Advisory Technical Sub-Committee of the Executive Committee, consisting of President A. M. Schoen, Vice-President F. T. Moses and Past President Dana Pierce, was appointed for consideration of technical matters upon which the Executive Committee may desire counsel. It was voted to constitute as a panel the chairmen of the Association's technical committees, from which the Advisory Technical Committee was authorized to add to its number when desired for consideration or clarification of any special item.

Following the unanimous recommendation of the Association at the annual meeting, the title of Managing Director was conferred upon the Secretary-Treasurer.

The item of the amendment of Rule 611 of the Automatic Sprinkler Regulations was considered in connection with various communications from members on the subject, and it was voted that the Executive Committee feels without power to void the action of the Association in making this amendment.

It was voted that no action be taken at present respecting the submission of the Sprinkler Regulations to the American Engineering Standards Committee for registration.

The Executive Office was authorized to proceed to submit the N.F.P.A. report on Protection of Records to the American Engineering Standards Committee for approval as "American Recommended Practice."

The Executive Office was authorized to proceed, with the advice and coöperation of the special Publications Committee appointed at the mid-winter meeting, to advance the project of the acceptance of advertising in the Association's *Quarterly*.

The Executive Office was directed to proceed with the preparation for publication of an Electrical Field Practice Manual to be uniform with the Association's manual of general field practice, to be produced by a committee to be appointed in consultation with Electrical Field Engineer Victor H. Tousley, who is to be chairman thereof.

It was voted to request the Electrical Committee to give consideration during the coming year to the matter of the reconciliation of implied differences between paragraphs on the protection of spray finishing hazards in the 1928 National Electrical Code and in the Association's regulations governing this subject.

As per authority conferred by the Association in annual meeting, the text of the revised National Electrical Code for 1928 submitted by the Electrical Committee was approved. It was voted to submit the same to the American Engineering Standards Committee for approval as American Standard, and authorize a special appeal to that organization for immediate consideration. It was voted to certify the text to the National Board of Fire Underwriters for publication.

A special sub-committee, consisting of President A. M. Schoen, Geo. W. Elliott and W. E. Mallalieu, was appointed to give consideration to the organization of the Electrical Committee and the general subject of its make-up, with a view to balanced representation and its methods of procedure. It was voted to refer to this sub-committee a communication from the National Electric Light Association (Member N.F.P.A.) concerning certain items in the text of the 1928 Electrical Code.

It was voted to unite with the other members of the Fire Protection Group of the American Engineering Standards Committee in approval of the specifications for Cotton Rubber Lined Hose for public and private fire department use developed by the sectional committee under the joint sponsorship of the American Society for Testing Materials and the Fire Protection Group.

Mr. A. R. Small, representative of the Fire Protection Group in the American Engineering Standards Committee, was authorized to vote N.F.P.A. approval of the revised constitution and by-laws and rules of procedure of the A.E.S.C.

The resignation of Mr. Hickman Price as a member of the Executive Committee was accepted, and Mr. Eugene Chrystal appointed to fill the vacancy until the next meeting of the Association.

Committee Revisions.

Mr. Edward P. Boone of New York was appointed Chairman of the Committee on Automatic Sprinklers.

Mr. C. W. Pierce of New York was appointed Chairman of the Committee on Signaling Systems.

Recommendations of the chairmen of N.F.P.A. committees and other members for additions to and revisions of present committee rosters were considered, and the changes made in consequence of the same will appear in the forthcoming Year Book. The Executive Office was authorized to make certain further committee revisions now the subject of correspondence.

Fighting Fires Beforehand.

By C. W. Mowry (Member N.F.P.A.)
Associated Factory Mutual Fire Insurance Companies.

The thought of fighting fires beforehand is suggested by the following story which appeared in *Harper's Magazine.*

During the Russian-Japanese War, an American newspaper correspondent arrived at the Japanese Army Headquarters at the height of one of the worst battles in the Manchurian campaign. The correspondent expected to find material for a good story in the excitement and anxiety which he supposed always prevailed at an army headquarters during a battle; but he was greatly surprised to find everything quiet and peaceful, with General Kuroki, Commander-in-Chief of the Japanese Army, sitting on the bank of a near-by stream, calmly fishing. As soon as the correspondent had presented his credentials, he obtained an interview with the general; and at the close of the interview he said, as tactfully as possible, "You don't seem to be greatly concerned about the outcome of this battle." "No," replied the wily little Jap, upon whose shoulders rested the entire responsibility, "No; I fought this battle two years ago back in Tokio."

Just as some battles can be fought beforehand, so can some fires be fought beforehand by careful planning in advance, by anticipating emergencies, and by preparing for them.

Only a short time ago Deputy Chief McLean of the Boston Fire Department, in a lecture before his men at the Fire College, said, "We have reached the peak in fire fighting. We must look to fire prevention and automatic sprinklers if we are going to stop our wholesale burnings."

At the very moment when he was uttering these words, by a strange coincidence, the Fall River conflagration was confirming what he said.

The Pocasset Mill, where the Fall River fire started, was a large 6-story stone cotton mill which for more than forty years had been protected by automatic sprinklers. During these years, while the mill was in operation, the sprinklers had put out thirty-two fires with small or trivial loss. And yet after the machinery and stock had been removed from the plant and the sprinkler system had been taken out in anticipation of tearing down the buildings, a fire started in the engine room, due, it is said, to the carelessness of workmen, and gained such headway before it was discovered that the entire Fall River fire department was unable to confine the fire to the mill buildings. Help from twenty-two surrounding towns and cities was required to check the resulting conflagration. This was another of those wholesale burnings which

Address before the Thirty-second Annual Meeting of the N.F.P.A., Atlantic City, May 9, 1928.

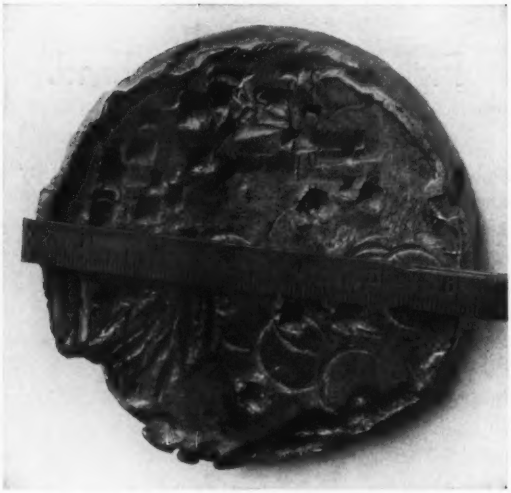


Fig. 1. What a Drain Test Disclosed. This lead disc almost totally obstructed the flow to nearly five hundred sprinkler heads. The indentations on its surface were made while trying to remove it from the pipe.

Chief McLean of Boston was talking about when he told his men they must turn more and more to fire prevention and automatic sprinklers, two of the things which this Association has stood for so many years. To discuss even briefly the various ways in which fires can be prevented and the many types of fire protective equipment available would take more time than we have this evening; but whatever safeguards are adopted or whatever protective equipment is installed, preparedness is essential,—that is, being prepared and ready to put out as quickly as possible those fires which are not prevented.

The records of this Association, as published annually in the *Quarterly*, show that of 39,000 fires which occurred in sprinklered buildings, 51 per cent were extinguished by two sprinklers or less, 81 per cent by eight sprinklers or less, and 91 per cent by 20 sprinklers or less. Practically 100 per cent efficiency can be obtained if sprinklers always have a good reliable water supply. Therefore, an important part of fighting fires beforehand is to make greater use of automatic sprinklers and then to make sure by periodic inspections and tests that sprinkler valves are kept open, that supply pipes are clear, and that the water supply is ample.

Water-flow tests by insurance inspectors and others reveal many unsuspected dangerous conditions. An inspector of the Underwriters Bureau of New England tells an interesting story about testing a new sprinkler system in Salem, Massachusetts. When he opened the sprinkler drain the gage pressure on the sprinkler riser dropped nearly to zero, but rose slowly to normal again when the drain was closed. A thorough inspection of the valves and

Fig. 2. Material Found Obstructing Fire Pumps. A stick and two pieces of a tin can (left) clogged the impeller of one fire pump. The material at the right was taken from another centrifugal fire pump.

supply pipe indicated a clear waterway until the Smith connection to the 20-inch street main was reached. Then it was discovered that the 1-inch drill used first in making the connection had penetrated the wall of the pipe, but that the cutting out of the disc had not been completed. Consequently, the only supply to the 6-inch sprinkler riser was the 1-inch drill hole.

One of our own inspectors found a lead disc six inches in diameter, one inch thick, and weighing over 11 lbs. which completely obstructed the supply to nearly 500 sprinklers. The inspector was examining the system for approval and obtained no water from the sprinkler drain. All valves were found open, but upon removing the elbow at the base of the riser the disc of lead was found in the waterway of the controlling valve and was holding back 76-lb. pressure. Evidently the gate valve and the attached nipple were assembled before being lowered into the trench, and the valve was stood on its end while the lead joint was being poured. A leak evidently existed in the yarn caulking, permitting the lead to flow onto the surface of the valve gate. The man pouring the joint apparently did not notice the excessive amount of lead being used.

Last summer during the test of a 750-gallon fire pump, a 20-inch vacuum was indicated in the suction line from the city main. A meter had been placed on this suction line, and the condition of its screen was therefore investigated. It was found that nine-tenths of the 3/16-inch holes were obstructed by snail shells. The total area of the holes, even when clear, was less than that of the 8-inch suction line. Experience has indicated that to insure an adequate quantity of water for a pump a screen should have an effective area of ten times that of the pipe if the suction is from a pond, river or other body of water likely to contain much foreign material, but when the supply is from the street main, as in this case, about five times the area of the suction pipe is sufficient.

Foreign material is frequently found in the impellers of centrifugal pumps. Small stones and pieces of wood will clog the narrow outlets of the

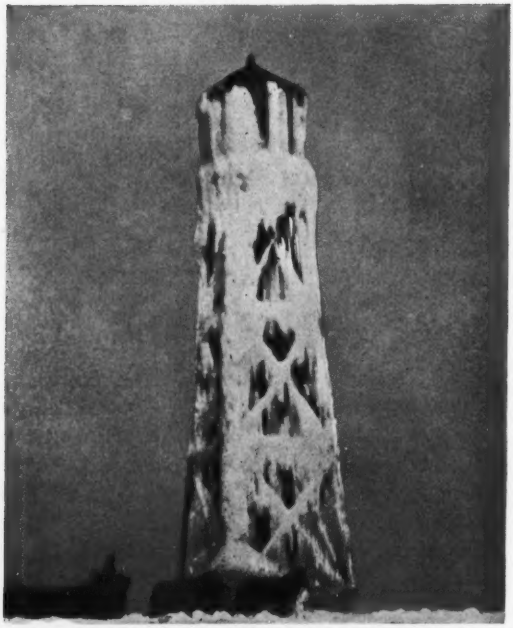


Fig. 3. A Dangerous Burden of Ice. Sprinkler tanks are sometimes overflowed to prevent freezing, with the result that the entire structure is seriously overloaded with ice.

impellers without appreciably affecting the smoothness of operation. This cannot be detected by merely running the pump, but only by observing the pressure and measuring the discharge. In one recent case a delivery of 1200 g.p.m. at only 35-lb. pressure was obtained at first from a 1500-gallon pump until the clogged impellers were cleaned, when the full rated capacity at 100-lb. pressure was delivered.

Sometimes the primary supply for sprinklers is from a sprinkler tank. It is a part of the job of fighting fires beforehand to keep these tanks full and free from ice. Sprinkler tanks are sometimes overflowed to prevent freezing, with the result that the entire structure is dangerously overloaded with ice. Tank towers are not designed to carry such a burden, which has caused the collapse of several structures. In order to determine the amount of heat necessary to prevent tanks from freezing, careful observations of tanks at various localities were made by the Factory Mutual Laboratory engineers for several winters. Temperature readings of the air and water were taken; and the amount of steam required to supply the radiation-loss was carefully measured. From these data and the record of the lowest one-day temperature throughout the country, obtained from the United States Weather Bureau, tables have been prepared giving the correct size of heater for tanks of

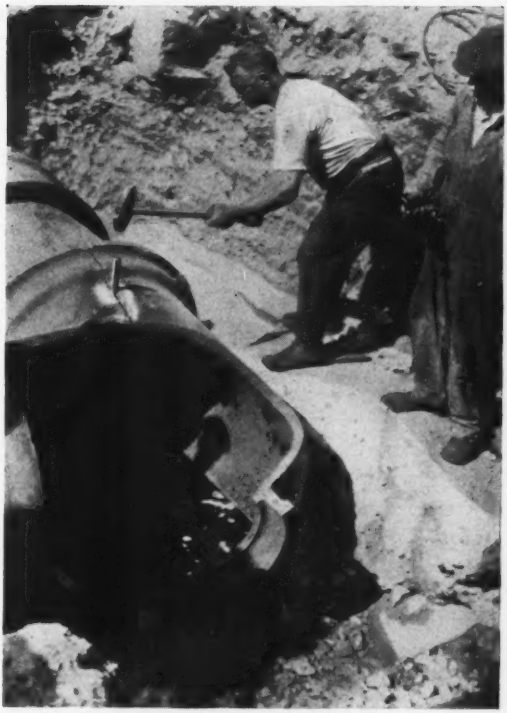


Fig. 4. Removing a Broken Tee. This large tee in a water supply main at Central Falls, R. I., broke, and Central Falls and Pawtucket were without water for four hours until valves could be closed. This shows the process of removing the broken tee, prior to replacement.

various sizes and for any location in the country. These tables are now included in the specifications for sprinkler tanks, published both by the National Board of Fire Underwriters and the Factory Mutual Companies.

Last summer, while an inspector was making the usual water-flow tests at a plant in Cleveland, Ohio, no water could be obtained from the tank which constituted the primary supply for the sprinklers. All valves were examined and found open. The clapper of the tank check-valve was removed and it was discovered that the base of the tank-drop was entirely obstructed. The cover of the check was bolted on again, and then, by means of the fire pump, two or three pailfuls of scale were forced out through the 3-inch drain. Upon inquiry it was learned that the tank had recently been scraped and painted inside and out, and that when it came to removing the scale from the inside the painters adopted the easiest means of getting rid of it—by dropping it down the tank riser.

Discovering troubles of this kind with the water supply, finding out what

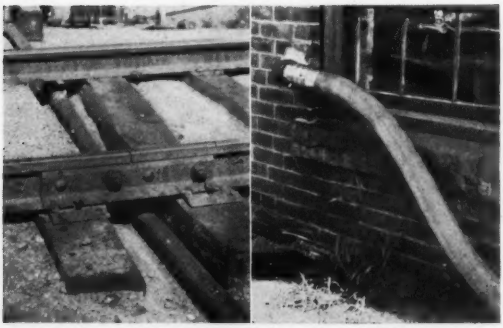


Fig. 5. An Emergency Sprinkler Supply. During eleven days' local interruption of the public water supply, due to the broken tee shown in Fig. 4, sprinklers at the Pawtucket Spinning Ring Company were supplied by a line of fire hose taken from a hydrant still in service and laid under the railroad tracks, and connected into the riser drain.

is the matter and removing the obstructions, show the value of thorough flow tests as one of the important ways of fighting fires beforehand.

No supply for automatic sprinklers is quite so satisfactory as a good public water system. It is so reliable that we think of it as infallible; but sometimes it fails. Last June a large tee in an important supply main at Central Falls, R. I., broke at about eleven o'clock at night. The pressure in the mains dropped to almost nothing, and Pawtucket and Central Falls were without water for four hours. Fortunately no fires occurred during this period, but about 7,000,000 gallons of water escaped from the reservoir. By three o'clock in the morning the break had been isolated and the pressure restored, except in a small locality, which was without water for thirteen days. To obtain fire protection during this period of interruption, the Pawtucket Spinning Ring Company, which had no secondary supply to sprinklers, ran a line of hose from a hydrant at an adjoining plant, carried it under the railroad tracks between the sleepers, and connected it to the drain valve on the sprinkler riser. In this way they maintained their sprinklers ready to function in case of fire. It was anticipating an emergency and preparing for it. This should always be done when automatic sprinklers which are depended upon for protection are temporarily deprived of their water supply.

Let us now turn our attention to another way of fighting fires beforehand. A paper mill can be protected by automatic sprinklers, but millions of dollars worth of logs stored in the yard during the summer months to insure continuous operation during the winter cannot be protected by automatic sprinklers. The individual piles are 300 to 400 feet long, 200 feet wide, and 60 to 80 feet high. A single pile may contain 20,000 cords of wood worth $300,000. During the summer, when the surface of the log piles has been thoroughly dried by the wind and sun, sparks from a locomotive puffing up a grade sometimes land on top of a pile of pulpwood and start a fire. No ordinary hose stream can reach

Fig. 6. Not a Volcano in Action. A threatening fire near the top of a pulpwood pile. Unless water is applied at the very start it is almost impossible to check a fire in one of these piles.

the top of the pile from the ground, and you can readily appreciate what a difficult and hazardous undertaking it is for men to attempt to climb up over the logs with a line of hose. Unless water is applied at the very start it is almost impossible to check a fire in one of these piles.

The sparks and embers drop down into the pile. The air filters in through the spaces between the logs and maintains combustion in the interior, while the water from the hose streams is largely shed from the surface. This process goes on when once started, burrowing deeper and deeper until the entire pile is on fire. Later on, the pile resembles a mountain of live coals, which it really is; and when the fire has reached that stage it is impossible to extinguish it and the pile burns down to a fringe of charred logs.

Although automatic sprinklers cannot be utilized to protect this valuable log-pile storage, a highly effective protection is available by means of monitor nozzles capable of concentrating powerful streams on any part of a pile. The log storage is subdivided into units of 10,000 to 20,000 cords with 100-foot clear spaces between them. The ends of some of the piles are provided with

Fig. 7. Too Late for Hose Streams.
13,000 cords of spruce in this pile were destroyed by a fire which burned itself out in 72 hours.

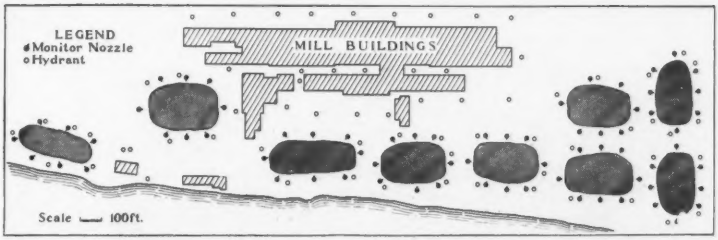


Fig. 8. Ringed Around with Protection. Piles separated into units of 10,000 cords each and 100 ft. apart, and surrounded by monitor nozzles and hydrants backed by 5500 g.p.m. pumping capacity. Incipient fires are controlled at the start.

concrete barriers to define the clear spaces which should be maintained between the piles. Clean conditions prevail in the yard, and concrete houses are used for the motors driving the conveyors, all with a view of reducing the fire hazard to a minimum.

The monitor nozzles are spaced around the piles at intervals of about 150 to 200 feet and are interspersed with hydrants for supplementary protection. Some of the monitor nozzles are located at ground level and others on towers to reach over the sides of the pile, which may be "corded up" ten to twenty feet because of limited yard room.

If the watchman patrolling such a log yard should discover a fire, he can proceed instantly to one of these nozzles without having to call for help. Without spending any time whatever to lay hose, he can direct one of these nozzles toward the fire, and by merely opening a valve can throw a powerful stream of 1000 g.p.m. on the fire in a moment or two. And then, leaving this stream playing on the blaze, he can go to another nozzle and apply a second stream, all within a very few moments. Several incipient log-pile fires have already been extinguished in this manner. While the watchman's part in extinguishing such fires was a very important one, nevertheless the fires were largely fought beforehand when this method of protection was developed and the owners installed it and maintained it ready for instant use.

So far we have discussed ways of fighting fires beforehand inside of buildings and outside in yards used for storing log piles. Exposure fires also can be fought beforehand. Only this afternoon Mr. Bell told us how he prepared in advance to protect the Hotel Chalfonte buildings against fire exposure on the south. He installed open sprinklers on the tall wooden buildings, provided wired glass in the hotel windows, and mounted monitor nozzles on the balconies. Twice within the past year has his foresight been justified and rewarded. Last winter, when the building just south of the hotel burned, the wired glass and monitor nozzles saved the building; and more recently, when the Hotel Iroquois was destroyed with unfortunate loss of life, the open sprinklers undoubtedly saved the Chalfonte dormitories. Mr. Bell can say with pride that he fought these fires beforehand.

Fig. 9. Elevated Monitor Nozzle. Each nozzle, capable of delivering 1000 g.p.m. at good pressure, is mounted on a steel tower protected on the exposed side toward the fire by a wall of concrete blocks.

Another exposure fire was fought beforehand not long ago at Waterbury, Conn. The Waterbury Clock Company have a 5-story factory used for clock assembly and the storage of finished parts. Along one side of this building and less than ten feet away was a row of 2- and 3-story unsprinklered wooden buildings used for bottling patent medicines and known to contain several hundred gallons of alcohol. The Waterbury Clock Company realized that these buildings were a serious fire exposure to their property and determined that they would be prepared to protect their own building if it ever became necessary. The large windows facing the exposure were equipped with wired glass and with two rows of open sprinklers, one at the third and one at the fifth story. The watchmen were instructed how to turn on the sprinkler systems. Eighty bags of sawdust were kept ready in the building for use in case of leakage around the windows or in case the heat should open the inside sprinklers. The basement was drained and the goods there were stored on skids. Advance preparations were well made.

Within two years the expected fire came, at a time well suited to test the defense that had been prepared. At three o'clock in the morning a passing policeman saw flames in one of the wooden buildings and gave the alarm. Another fire was in progress in the city at the same time, so that only a part of the apparatus responded at first. This caused some delay in getting a

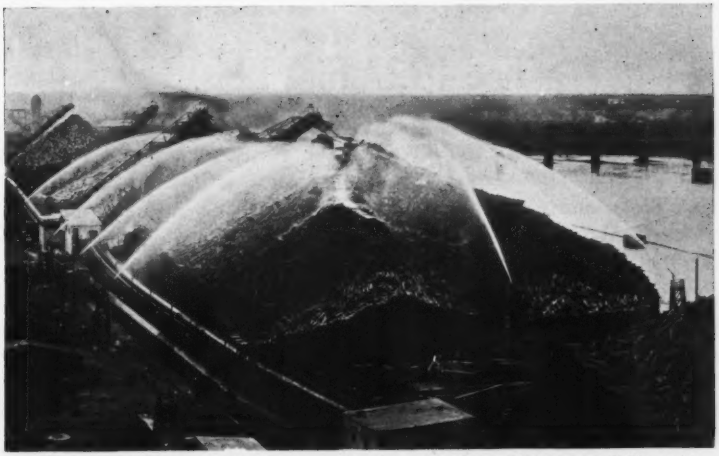


Fig. 10. Deluged by Water from Monitor Nozzles. 5000 g.p.m. delivered on to one pile in a few minutes by a small crew. No time lost in laying hose lines.

sufficient number of hose streams into action quickly, with the result that the fire gained considerable headway. The watchman, however, was alert. He turned on the outside sprinklers and started the fire pump in order to supply them with ample water.

A gale of wind drove the flames directly against the windows of the Waterbury Clock Company. The wind also drove the water from the open sprinklers and from hose streams in around the windows. The night crew, under the direction of the superintendent, used the sawdust to confine the water, and with brooms swept it down the stairway to the basement. For four hours the fire lasted. At times the heat radiated through the water curtain and the windows to such an extent that it was feared the automatic sprinklers within the building would open. To prevent this the windows on the side of the building away from the fire were kept open until the fire department had the fire under control.

The Waterbury Clock Company suffered no fire loss whatever, and merely a nominal water loss. The next morning business was resumed as usual. The superintendent could truly say with General Kuroki, "I fought this battle two years ago."

When an owner has spent money for sprinklers, fire-pump, tank, open sprinklers, or other fire protective equipment, he has purchased tools for use at the time of a possible fire. Mere possession of these tools, however, is no guarantee against loss. The equipment must, by proper care and maintenance, be kept ever ready for the time when fire will put it to the test, and men must be trained to use it intelligently. For emergency-readiness there must be every-day preparedness. This is truly fighting fires beforehand.

The 1927 Fire Loss.

The total fire loss for the United States is $478,245,620 according to the estimates of the Actuarial Bureau of the National Board of Fire Underwriters presented in the current report of their Committee on Statistics and Origin of Fires. This estimate is based upon returns made by the insurance companies reporting to the Actuarial Bureau, adding twenty-five per cent for uninsured and unreported losses. These figures should be distinguished from the estimates compiled by the New York *Journal of Commerce* and published in the *Quarterly* for January, 1928.

The 1927 fire loss is approximately $82,000,000 less than the loss of 1926, a decrease of about fifteen per cent. The 1927 figure is the lowest loss reported by the Actuarial Bureau since 1920. The per capita loss for the country as a whole is set at $4.01, and the average per capita loss for cities is given as $2.82, both figures being the lowest since 1919.

The per capita losses of the cities of over 100,000 population are given in the following tables. There also appears a table of all cities of over 20,000 population where the per capita fire loss exceeded five dollars during the past year. The fire loss figures of cities are for the most part fire department estimates and as such may be somewhat lower than the losses reported by the insurance companies. It is also noted that these figures may not be estimated in all cases upon the same basis and that they may in some cases be inconclusive if taken for a single city for a single year, particularly in the case of the smaller cities where a single large fire may materially distort the per capita figure. Nevertheless, the per capita fire losses are considered the best available index by which to compare the fire record of cities, and a high per capita fire loss continuing over a period of years is considered conclusive evidence of the true conditions.

Comparative U. S. Fire Losses.

	Population	Total Loss	Per Capita
1923—Whole country	110,663,502	*535,372,782	4.84
372 cities	42,946,639	†147,102,119	3.42
1924—Whole country	112,078,611	*549,062,124	4.90
366 cities	43,375,796	†146,222,749	3.37
1925—Whole country	115,378,094	*559,418,184	4.85
370 cities	45,297,469	†160,011,951	3.53
1926—Whole country	117,136,000	*560,548,624	4.79
377 cities	53,243,778	†178,178,874	3.35
1927—Whole country	119,320,000	*478,245,620	4.01
406 cities	51,291,549	†144,618,641	2.82

*Estimated from Records of the Actuarial Bureau. †Figures reported by fire departments.

Cities in Which Loss Exceeded $5.00 Per Capita in 1927.

†Montgomery, Ala.	$24.31	*New Albany, Ind.	$6.60
Bangor, Maine	21.91	Kansas City, Kansas	6.45
†Williamsport, Pa.	18.83	*Passaic, N. J.	6.32
Belleville, Ill.	17.75	Amsterdam, N. Y.	6.29
*Waukegan, Ill.	17.71	Evanston, Ill.	6.28
*Mason City, Iowa	11.88	Joliet, Ill.	6.01
‡Leominster, Mass.	10.45	‡Nashville, Tenn.	5.97
Quincy, Ill.	10.05	Newburgh, N. Y.	5.82
Harrisburg, Pa.	9.30	Salem, Ore.	5.73
Zanesville, Ohio	9.03	Schenectady, N. Y.	5.72
Milwaukee, Wis.	8.52	*Cedar Rapids, Ia.	5.70
*Duquesne, Pa.	8.49	Kingston, N. Y.	5.56
†Revere, Mass.	8.44	Elyria, Ohio	5.55
Charleston, S. C.	8.11	Hammond, Ind.	5.50
Stamford, Conn.	8.01	Orange, N. J.	5.40
**Springfield, Ill.	7.94	*Scranton, Pa.	5.27
†Jackson, Miss.	7.75	Anderson, Ind.	5.20
‡Peabody, Mass.	7.68	Northampton, Mass.	5.16
*West New York, N. J.	7.56	‡Danville, Ill.	5.15
New Brunswick, N. J.	7.52	Winston-Salem, N. C.	5.13
Bristol, Conn.	7.27	New Castle, Pa.	5.09
*Charleston, W. Va.	7.00	Alliance, Ohio	5.08
*Sacramento, Cal.	6.78	**Dallas, Texas	5.06
*Atlantic City, N. J.	6.78	‡Everett, Mass.	5.05
*Lincoln, Nebr.	6.77	North Adams, Mass.	5.04
†Gloversville, N. Y.	6.71	Jackson, Mich.	5.03
*Lynn, Mass.	6.60		

*These cities in this class in two of the last five years.
†In this class three of the last five years.
‡In this class four of the last five years.
**In this class five consecutive years.

Per Capita Fire Losses of Cities Over 500,000 Population.

	1923	1924	1925	1926	1927	Five-year average
Boston, Mass.	$8.18	$6.19	$6.97	$6.59	$4.92	$6.57
Buffalo, N. Y.	5.24	5.01	5.79	3.84	3.51	4.68
St. Louis, Mo.	3.45	4.15	3.95	3.09	3.23	3.57
Chicago, Ill.	1.97	2.23	3.75	4.86	4.39	3.44
New York, N. Y.	3.31	3.16	3.21	3.66	3.30	3.33
Detroit, Mich.	3.99	3.17	3.16	2.73	3.27	3.26
Pittsburgh, Pa.	2.23	3.58	3.43	3.37	3.42	3.21
Philadelphia, Pa.	4.11	2.38	3.23	2.93	2.08	2.95
Milwaukee, Wis.	3.91	2.94	2.84	2.64	1.98	2.86
Washington, D. C.	4.92	1.78	1.74	3.11	1.76	2.66
Baltimore, Md.	2.18	2.45	2.66	3.07	2.14	2.50
Cleveland, Ohio	2.18	2.41	2.97	2.46	2.37	2.48
Los Angeles, Calif.	1.67	1.61	1.47	1.77	1.60	1.62
San Francisco, Calif.†						

†Does not report its losses.

	1923	1924	1925	1926	1927	Five-year average
Cities from 400,000 to 500,000 Population.						
Kansas City, Mo.	7.18	6.95	8.95	4.13	3.17	6.08
Newark, N. J.	4.14		7.42	5.67	2.84	5.02*
Minneapolis, Minn.	3.82	4.23	3.64	3.10	3.09	3.58
New Orleans, La.	1.81	2.12	7.59	1.42	1.46	2.88
Cincinnati, Ohio	3.24	2.71	2.65	3.16	1.88	2.73
Seattle, Wash.	1.51	1.66	3.66	1.40	1.36	1.92
Cities from 300,000 to 400,000 Population.						
St. Paul, Minn.	5.13	4.99	4.16	3.10	4.72	4.42
Louisville, Ky.	6.69	3.51	4.46	4.30	2.09	4.21
Toledo, Ohio	4.52	2.31	4.30	3.57	2.70	3.48
Portland, Ore.	4.51	3.48	3.69	3.01	2.09	3.36
Indianapolis, Ind.	4.23	3.47	3.38	1.82	2.01	2.98
Jersey City, N. J.	.97	5.15	1.84	.76	4.15	2.57
Columbus, Ohio	3.94	1.91	1.89	3.12	1.79	2.53
Oakland, Calif.	2.59	4.66	1.38	1.87	2.17	2.53
Denver, Colo.	2.12	3.02	1.96	1.42	1.57	2.02
Rochester, N. Y.	1.86	3.06	1.71	1.51	1.39	1.91
Cities from 200,000 to 300,000 Population.						
Dallas, Texas	10.06	7.88	9.27	7.60	5.06	7.97
Omaha, Nebr.	11.43	4.28	2.43	3.08	2.97	4.84
Memphis, Tenn.	6.04	4.13	5.44	3.36	2.88	4.37
Providence, R. I.	7.21	4.29	2.28	3.78	2.78	4.07
Birmingham, Ala.	4.56	4.83	4.45	3.07	3.25	4.03
Atlanta, Ga.	2.80	4.60	4.64	3.80	3.99	3.97
Houston, Texas			3.89	4.16	3.28	3.78*
Worcester, Mass.	3.52	3.61	3.03	4.97	3.49	3.72
Syracuse, N. Y.	4.81	2.66	1.60	3.90	1.32	2.86
Richmond, Va.	2.05	2.53	2.74	2.75	2.04	2.42
Akron, Ohio	2.46	1.02	1.99	.91	1.19	1.51
San Antonio, Texas	1.27	1.57	2.28	.99	.65	1.35
Cities from 150,000 to 200,000 Population.						
Fort Worth, Texas	$4.72	$9.54	$8.65	$3.44	$4.91	$6.25
Grand Rapids, Mich.	8.03	6.90	4.98	1.90	1.73	4.71
Scranton, Pa.	3.91	4.24	5.36	4.47	5.27	4.65
Paterson, N. J.	2.78	3.47	2.91	7.45	4.29	4.18
New Haven, Conn.	2.90	5.43	3.83	4.18	3.66	4.00
Tampa, Fla.	2.16	2.38	5.93	4.89	2.22	3.52
Des Moines, Iowa	2.36	5.50	4.51	2.59	1.79	3.35
Youngstown, Ohio	3.94	3.69	3.12	2.63	2.45	3.17
Jacksonville, Fla.	2.35	3.67	3.23	2.94	2.55	2.95
Norfolk, Va.	4.91	3.04	2.52	1.79	1.93	2.84
Salt Lake City, Utah	2.14	3.17	2.24	2.98	2.43	2.59
Flint, Mich.	2.99	2.05	3.19	3.23	1.18	2.53
Hartford, Conn.	1.45	3.43	1.86	3.00	1.54	2.26
Dayton, Ohio	1.58	.91	1.27	6.29	1.25	2.26
Tulsa, Okla.	1.72	1.71	1.64	.99	.49	1.31
Long Beach, Calif.	.44	1.67	1.03	1.08	1.16	1.08

*Less than five-year average.

Cities from 125,000 to 150,000 Population.

	1923	1924	1925	1926	1927	Five-year average
Nashville, Tenn.....	6.55	4.52	6.41	6.83	5.97	6.06
Miami, Fla.....				4.91	3.31	4.11*
Spokane, Wash.....	4.64	5.26	2.69	4.41	2.53	3.91
Springfield, Mass.....	6.14	2.82	2.76	3.10	2.43	3.45
Fall River, Mass.....	1.57	3.37	2.11	4.71	2.83	2.92
Kansas City, Kansas.	1.13	2.77	1.50	1.76	6.45	2.72
Tacoma, Wash.....	2.15	4.22	2.34	1.83	2.85	2.68
Oklahoma City, Okla.	4.79	1.78	1.80	3.52	1.11	2.60
Trenton, N. J.....	2.04	1.85	3.37	1.42	1.59	2.05
Chattanooga, Tenn...	2.10	3.64		2.65	1.42	1.96*
Erie, Pa.....	2.61	1.63	2.36	1.04	.90	1.71
Bridgeport, Conn.....	.55	1.44	1.25	1.90	1.36	1.30
Camden, N. J.....	1.07	3.85	.34	.28	.78	1.26

Cities from 100,000 to 125,000 Population.

Lynn, Mass.....	4.13	11.71	4.40	4.78	6.60	7.90
Lowell, Mass.....	5.44	8.66	3.13	14.43	2.20	6.77
Duluth, Minn.....	6.52	3.73	5.71	5.41	3.82	5.04
Cambridge, Mass.....	3.85	7.15	3.07	5.38	3.79	4.65
South Bend, Ind.....	4.05	2.63	5.58	7.59	2.11	4.39
Sacramento, Calif....	4.35	6.10	1.84	1.65	6.78	4.14
Wichita, Kansas.....	6.77		3.27	4.85	1.22	4.03*
New Bedford, Mass..	2.21	9.72	2.64	2.99	1.82	3.88
Fort Wayne, Ind.....	1.90	7.58	3.59	2.10	3.93	3.82

[*Continued on next page*]

Annual Fire Losses in the United States for Fifty-three Years.

Year	Property Loss	Year	Property Loss	Year	Property Loss
1875.....	$78,102,285	1893.....	$167,544,370	1911.....	$217,004,575
1876.....	64,630,600	1894.....	140,006,484	1912.....	206,438,900
1877.....	68,265,800	1895.....	142,110,233	1913.....	203,763,550
1878.....	64,315,900	1896.....	118,737,420	1914.....	221,439,350
1879.....	77,703,700	1897.....	116,354,575	1915.....	172,033,200
1880.....	74,643,400	1898.....	130,593,905	1916.....	258,377,952
1881.....	81,280,900	1899.....	153,597,830	1917.....	289,535,050
1882.....	84,505,024	1900.....	160,929,805	1918.....	353,878,876
1883.....	100,149,228	1901.....	165,817,810	1919.....	320,540,399
1884.....	110,008,611	1902.....	161,078,040	1920.....	447,886,677
1885.....	102,818,796	1903.....	145,302,155	1921.....	495,406,012
1886.....	104,924,750	1904.....	229,198,050	1922.....	506,541,001
1887.....	120,283,055	1905.....	165,221,650	1923.....	535,372,782
1888.....	110,885,665	1906.....	518,611,800	1924.....	549,062,124
1889.....	123,046,833	1907.....	215,084,709	1925.....	559,418,184
1890.....	108,993,792	1908.....	217,885,850	1926.....	560,548,624
1891.....	143,764,967	1909.....	188,705,150	1927.....	478,245,620
1892.....	151,516,098	1910.....	214,003,300		

NOTE:—Previous to 1926 figures obtained from the records of the New York *Journal of Commerce*, deducting the Canadian losses. Subsequent years are based on returns to Actuarial Bureau of the National Board of Fire Underwriters, adding 25% for unreported and uninsured losses.

Cities from 100,000 to 125,000 Population (Continued).

	1923	1924	1925	1926	1927	Five-year average
Albany, N. Y.	3.81	2.83	4.08	3.85	3.78	3.67
Reading, Pa.	4.47	1.74	2.86	6.26	1.26	3.32
Knoxville, Tenn.	1.29	4.55	4.82		2.61	3.32*
Utica, N. Y.	5.01	3.00	3.01	1.94	1.86	2.96
Waterbury, Conn.	1.85	1.29	3.76	3.92	3.25	2.81
Gary, Ind.	.80	1.41	5.96	3.39	1.84	2.68
Somerville, Mass.	2.33	2.22	4.13	2.57	1.96	2.64
Savannah, Ga.	6.52	1.38	2.60	1.09	1.45	2.61
Elizabeth, N. J.	2.96	1.58	3.48	3.22	1.68	2.58
Allentown, Pa.	.14		3.74	1.99	4.02	2.47*
El Paso, Texas	1.51	2.68	2.21	3.27	.79	2.09
Yonkers, N. Y.	1.51	1.56	1.42	1.89	1.70	1.62
Canton, Ohio	3.61	1.84	.93	.62	.44	1.49
Wilmington, Del.	1.28	1.95	1.43	.65	1.83	1.43

*Less than five-year average.

Canadian Fire Losses, 1927.

Fire losses in Canada in 1927 were some eight million dollars less than the preceding year, the total losses showing a progressive decrease since 1922, according to statistics compiled by the Dominion Fire Prevention Association and given in the tables printed below. The decrease in total fire loss is even more significant in view of an increase in property values of 26 per cent from 1922 to 1927, according to Dominion Fire Commissioner, J. Grove Smith. In 1922 property in Canada had a total insured value of $7,934,838,000 and in 1927 $9,944,055,853. In 1922 the loss per $100 of value at risk was $0.50, and in 1927 $0.26. If fire losses from 1922 to 1927 had maintained the same rate of increase as property values, the total loss in 1927 would have amounted to almost $68,000,000.

The first table is of particular interest in that it shows a decrease in total fire cost, as well as in direct fire loss. If it were possible to estimate and include the indirect fire losses, due to interruptions to business, etc., as well as the direct losses, the total saving would doubtless be even greater.

What Fire Cost Canada in the Past Six Years.

	1922	1923	1924	1925	1926	1927
Value of Property Destroyed	$54,370,688	$48,570,759	$45,906,531	$40,729,724	$38,395,096	$32,254.084
Insurance Premiums in Excess of Losses Paid	16,529,907	20,472,375	21,590,380	27,246,031	30,884,862	31,336,804
Maintenance Cost of Municipal Fire Protection	23,247,950	24,170,420	24,659,204	25,103,246	25,970,803	26,204,915
Installation and Maintenance Cost of Private Fire Protection	8,431,050	8,873,200	8,994,500	9,374,815	9,846,725	9,908,770
Total	$102,599,595	$102,086,754	$101,150,615	$102,453,816	$105,097,486	$99,704,573

A Decade of Fire Losses in Canada.

Year	Property Loss	Per Capita	Year	Property Loss	Per Capita
1918	$33,870,000	$4.12	1924	$45,906,500	$4.99
1919	25,216,300	3.00	1925	40,729,724	4.35
1920	28,081,200	3.27	1926	38,395,096	4.15
1921	45,015,900	5.22	1927	32,254,084	3.29
1922	54,390,000	6.11			
1923	48,282,000	5.36	Total	$392,141,104	$43.86

Municipal Group Classification, 1927.

	Total Loss	Per Capita
Cities over 10,000 population	$13,303,093	$3.74
Towns 5,000 to 10,000 population	1,196,896	3.00
Towns 1,000 to 5,000 population	1,980,965	3.08
Villages under 1,000	4,701,324	4.02
Rural districts	11,071,806	2.93

Occupancy Group Classification, 1927.

Group	Number of Fires	Property Loss
Manufacturing risks	1,118	$5,954,027
Mercantile stores	3,261	6,047,619
Residential properties	19,304	7,830,925
Farm property (other than dwellings)	3,897	5,465,719
Institutional buildings	428	1,922,356
Miscellaneous property	3,720	5,033,438

Origin of Fires in Canada, 1927.

Causes Reported	No. of Fires
Stoves, furnaces and pipes (overheated or defective)	3,427
Smokers' carelessness	2,918
Sparks on roofs	2,646
Electrical defects	2,503
Carelessness with matches	1,984
Defective chimneys and flues	1,601
Lightning	1,589
Coal oil and gasoline	1,332
Hot ashes and coals	1,276
Exposure	987
Supposed incendiary	845
Spontaneous combustion	712
Portable lamps and lanterns	686
Open fires	537
Fireworks	276
Miscellaneous known causes	3,031
Unknown causes	5,378
Total	31,728

Fatalities by Fire 1925-27.

Year	Men	Women	Children	Total
1925	84	92	171	347
1926	79	86	123	288
1927	86	107	272	465
Total	249	285	566	1,100

West Plains Garage and Dance Hall Disaster.

Thirty-eight people were killed and many seriously injured in an explosion and fire in West Plains, Mo., at about 11 P.M. on Friday, April 13. The building in which this loss of life occurred was a two-story structure occupied by a garage on the ground floor with a dance hall above. The building was about 100 x 150 feet in area. The walls were of brick; the floors and other interior construction of wood.

The coroner's jury which investigated the circumstances of the loss of life reached no definite conclusion and expressed no formal opinion as to the cause of the explosion. The force of the explosion was such as to indicate a mixture of gasoline vapor and air throughout the first floor such as to give practically a maximum explosive effect. According to the available information the garage had been closed during the evening. However, there was sufficient ventilation through open windows to make it appear unlikely that any such concentration of gasoline vapor would have been reached through ordinary leakage of automobile tanks. A forty-gallon wheeled gasoline tank, bearing the label of Underwriters' Laboratories, was found intact after the fire. No other gasoline was known to be in the building except that in the tanks of a few cars. Following the fire the body of the proprietor of the

Ruins of the dance hall and garage in West Plains, Mo., where thirty-eight people were killed and many injured in an explosion and fire on Friday, April 13, 1928.

This report has been prepared from data furnished by Secretary J. Burr Taylor of the Missouri State Fire Prevention Association (Member N.F.P.A.).

View of the common grave where some twenty unidentified bodies of victims of the dance hall disaster were buried.

garage was found where it had apparently been blown from a rear door of the building.

When the explosion occurred, according to the statements of the survivors, the floor of the dance hall raised up and then dropped. The crowd in the dance hall at the time consisted of about thirty couples dancing, together with an orchestra and some others. Practically all of these people fell with the floor, many of them being imprisoned by the wreckage of the floor and roof. The ruins were in total darkness and indescribable horror prevailed. Within a very short space of time fire enveloped the wreckage and cremated those imprisoned who had not been able to escape.

The shock of the explosion seems to have been such that very few of those who did escape are able to give any clear account of just how they got out of the building. Some were able to work their way loose from the wreckage before the fire reached them. Some were apparently blown out of the building by the force of the explosion. As in the case of similar catastrophes in the past, it is very difficult to secure any consistent and accurate story of the exact happenings.

The bodies of those killed were so severely burned that in many cases it was impossible to identify them.

While there seems to be some doubt as to the exact cause and circumstances of the explosion, the lesson of this disaster is clear—the hazard of locating a place of public assembly over a garage, particularly in a building of ordinary construction.

Control of Electrical Equipment Sales in the City of Portland, Oregon.

By F. D. Weber, Electrical Engineer,
Oregon Insurance Rating Bureau (Member N. F. P. A.).

An electrical ordinance which not only regulates the installation of electrical wiring and equipment in accordance with the National Electrical Code, but controls the sale of electrical equipment, thus stopping at the source any distribution of unapproved devices and materials, has reduced the number of fires of electrical origin in Portland from 180 in 1922 to 4 in 1927.

When the City of Portland first adopted an electrical ordinance in 1911 it was fostered by the Electrical Workers' Union, and a pensioner of the Union was placed in charge of this inspection department. After having several inspectors of this type who did not have the best interest of the electrical inspection work at heart, a young college graduate, Mr. L. W. Going, became chief of the department in 1921. His technical experience and appreciation of the merits of having approved and standardized appliances and equipment for all electrical work guided him to coöperate closely with the Rating Bureau in drafting a new electrical ordinance in order that the sale of approved material could be regulated by the police authority of the City of Portland. Consequently in 1922 the ordinance was amended, and during the year 1923 the department began in earnest to enforce this feature of the city code, detailing one inspector to handle it. The ordinance, which is in effect today, was again amended in 1926, and it is well to point out that this ordinance was written with the coöperation of the whole of the electrical industry under the supervision of the Chief Electrical Inspector. The vital sections which govern the handling of approved materials are as follows:

APPROVED: When applying to materials and appliances shall mean that such material and appliances conform to the standards of the Underwriters' Laboratories, or to the specifications and requirements of the United States Bureau of Standards, and to the requirements of this Code. Whenever applying to workmanship, it shall mean workmanship that complies in all particulars with the provisions of this Code.

MATERIALS AND APPLIANCES: a. All materials and appliances used in the installations which are covered by this Code shall be approved. Unless otherwise specified in this Code, materials and appliances listed in the copyrighted lists of inspected appliances and supplements published and distributed by the Underwriters' Laboratories, shall be regarded as conforming to the requirements of this Section. It is not the intent of this rule to require that motors, meters and other devices which are not included in the list of inspected appliances issued by the Underwriters' Laboratories, shall be approved as defined above; but it is the intent to require that wiring, materials and devices, such as those included in the list of inspected appliances issued by the Underwriters' Laboratories shall be approved.

b. No materials or appliances which do not conform to the provisions of paragraph (a) of this section shall be sold or offered for sale, either in person or by agent, clerk or employee.

c. The maker's name, trade-mark or other identification symbol shall be placed on fittings and materials, together with such other markings giving voltage, current, wattage or other appropriate ratings as are prescribed elsewhere in this Code.

d. The requirements of this Code relating to materials, appliances and apparatus shall apply on all new electrical work whether the apparatus being installed is new or used. Where apparatus is moved from one location to another within the same building and for the same owner these requirements may be waived or modified, provided such apparatus has been examined by the Electrical Inspector and found to be in good safe condition. Used apparatus, with the exception noted herein, shall be remodeled to comply with the requirements of this Code before again placed in use.

The majority of the electrical ordinances in the United States attempt to handle this question by cut and dried phrases requiring that "all material, devices and appliances intended for use on light and power circuts shall conform to the standard of the Underwriters' Laboratories." This is good as far as it goes, but practical results are not obtained until the sale of the material is regulated the same as the sale of liquor, fireworks, narcotics, etc.

Licensing of Dealers and Contractors.

In order to handle the sale of electrical material, it was necessary to license dealers as well as electrical contractors. The following is the section of the ordinance governing the licensing of dealers:

Any person who sells or offers or exposes for sale any electrical device, apparatus or equipment designed for attachment to or installation on any electrical circuit or system, for light, heat or power, shall have an electrical dealer's license for each place of business conducted by such person, provided that such licensee may make a temporary demonstration of such articles elsewhere than at his licensed place of business without being required to have a license for such place of temporary demonstration.

There are four classes of licenses provided:

		Fee for First Year	Fee for Renewal
(a)	Electrical Construction	$50.00	$10.00
	Maintenance	5.00	5.00
	Electrical Dealer	5.00	5.00
	Supervising Electrician	1.00	1.00

(b) All licenses shall be for the calendar year or fraction thereof, and shall be obtained on or before January 2nd of each year, and shall expire at midnight on December 31st. Where a license is obtained after July 1st, the respective license fees shall be half the amount noted in paragraph (a) of this section; provided, however, that as to Supervising Electrician and Electrical Construction licenses no such deduction shall be made.

Penalty for violation of this ordinance is as follows:

Any person, firm, company or corporation that violates, disobeys, omits, neglects or refuses to comply with, or resists, or opposes the execution of, or violates any of the provisions of, or who occupies or maintains any building or structure in which the electrical wiring and appliances are in violation of this ordinance shall be punished by a fine not exceeding Five Hundred ($500.00) Dollars, or by imprisonment of not more than six (6)

months, or by both such fine and imprisonment, and every person, firm, company or corporation shall be deemed guilty of a separate offence for every day such violation, disobedience, neglect or refusal shall continue, and shall be subject to the penalty of this section for each and every separate offence, and so much of any building or structure as may be erected or altered in violation of this ordinance shall be condemned and torn down at the expense of the person, firm, company or corporation erecting or altering the same.

Any person who directs, supervises or controls the installation, alteration, repair or maintenance of electrical equipment, wires or apparatus, except one who maintains a competent electrical maintenance man, who must also be licensed by the city, is required to have a supervising electrician's license. A contractor therefore must employ a supervising electrician, or he may be one himself.

The Portland ordinance provides for examination of supervising electricians by an examining board appointed by the mayor. After the examination has been passed the supervising electrician is registered and licensed, and must pay a renewal fee each year. The personnel of this board includes one competent electrical mechanic, one bona fide electrical contractor and one member at large.

In order to encourage electrical development and not work a hardship upon anyone, it has been the practice of the Electrical Department to allow the installation of materials and devices which have been submitted to the Underwriters' Laboratories for test and approval but have not as yet been listed, it being understood that the manufacturer would make any changes necessary to comply with the Laboratories' requirements if his material or device should fail upon test. The electrical division may grant "provisional approval" of electrical materials and devices under the conditions noted below:

A. Where no standard has been prepared by the Laboratories to which the appliance should conform.

B. Where no other materials or appliances of similar type are regularly listed by the Laboratories.

C. In emergency, temporary acceptance may be given to materials and devices not listed by the Laboratories, provided such materials and devices have been submitted to the Laboratories for test and approval. Such temporary acceptance will ordinarily be granted for a period of 90 days.

D. "Provisional approval" shall be granted only for such materials and devices which, in the opinion of the Chief Electrical Inspector, are reasonably safe.

E. "Provisional approval" applies only to the particular samples so "provisionally approved" and not to the line as manufactured, stored, sold, installed or attached.

In order that the ordinance will be flexible and to take care of new developments in the electrical industry, and also to decide differences in opinion between the chief inspector and other parties, there has been provided a Board of Appeal. The personnel of the Board of Appeal consists of three members appointed by the Mayor, who, by experience and training, are competent to pass upon the safety of installations and apparatus regulated by the

Code. The Board of Appeal can suggest legislation to the Council and also pass upon materials and methods equivalent to those required by the provisions of the ordinance.

Constitutionality of the Ordinance.

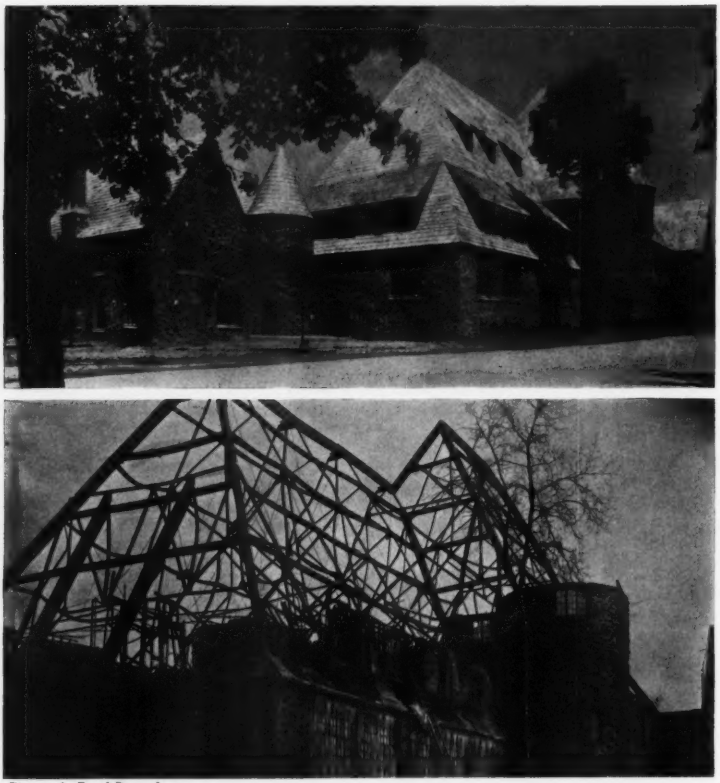
It has been stated by legal authorities that an ordinance similar to that enforced in Portland, Oregon, can be contested in the higher courts and declared unconstitutional. Although there may be some question as to the legal right of cities to control business by the establishment of a regulating license, there is little question but that a city does have the right by virtue of its police powers to enact and enforce legislation pertaining to the safety and general welfare of its citizens, as for example by prohibiting the sale of dangerous articles.

It is not to be understood that this ordinance has been self-enforcing and that it has not been necessary for the Electrical Department to assert its authority and cause action in the courts. The lower courts have sustained the ordinance in every indictment and have assessed penalties under it. As yet no one has appealed to the higher courts.

The electrical ordinance has had its effect on the decrease of electrical fires in the city of Portland, as they show a considerable decrease according to the fire department records, which are as follows:

1922	180	electrical	fires
1923	80	"	"
1924	42	"	"
1925	18	"	"
1926	12	"	"
1927	4	"	"

As the cities of the United States gradually adopt similar ordinances it will be much easier to enforce an ordinance of this kind, and Portland will not be pointed out as being "radical" and different from other cities. The cities which now have similar provisions in their electrical ordinances are as follows: Walla Walla, Wenatchee, Everett, Aberdeen, Washington; Lewiston, Idaho; Milwaukee, Wisconsin. The writer is also informed that Detroit and New York City (fostered by the Electrical Board of Trade) are planning on similar legislation.



Fireman's Fund Record.

Another "Fireproof" School Burns.

The pictures show the Cascia Hall School of the Augustinian Fathers at Tulsa, Oklahoma, before and after a fire which practically ruined the structure on January 2, 1928. The building was of unusual design and was partly fire resistive, with a roof of maximum pitch entirely of hand hewn shingles on steel supports. The building itself was of brick and concrete construction.

The cause of the fire has not been definitely determined. Late in the afternoon of the fire a chore woman had been in the third story with a blow torch, which she used to thaw out some pipes that were apparently frozen; it is possible that in thawing the pipes she may have started a small fire in a concealed place, which, not being seen, developed into the fire which destroyed the roof and upper floor. The loss is estimated at more than $50,000, or approximately 30% of the cost of building. The roof will be rebuilt entirely of slate.

Tests of the Severity of Building Fires.

By S. H. Ingberg (Member N.F.P.A.).

Chief, Fire Resistance Section, U. S. Bureau of Standards.

One of the main objects of public regulation of building construction is to prevent undue hazard to life and neighboring property from fire. Fire exposure to buildings and building members arises from interior and exterior origins. The evaluation of the exterior exposure can be done with difficulty in quantitative terms, and the gradual accumulation of data from actual fires will probably continue as the main guidance in providing the proper protection. The present paper will deal mainly with methods of gauging the severity of fires resulting from the burning out of contents of buildings whose wall, floor and column constructions are fire resistive to such an extent as to be capable of withstanding a complete burning out of building contents without collapse of major details. It is only when the problem is so confined that there is much possibility of obtaining experimentally quantitative information pertinent to the answer sought. The severity of fires completely consuming the combustibles of frame buildings and masonry-walled buildings with combustible interior construction is of interest mainly as it concerns the exposure to adjacent or neighboring buildings and the fire exposure on party and fire walls and on record containers. As it concerns the severity of fires in buildings with interior combustible construction protected with incombustible floor, ceiling and wall finishes, the present discussion will apply up to the limit set by the fire resistance of such protection.

The Standard Fire Test and Building Fires.

Indications of the intensity of building fires have been obtained from fused metals and from general fire effects on materials on which information is extant as to their reaction to temperature or fire exposure such as in test fires. The fire ruins or reports of fires give, however, little information on the duration of the temperatures in any given portion of the building. The absence of data to enable constructions or devices giving a certain performance in the standard fire test to be applied as protection against fire conditions in buildings with as much precision as results of strength tests are

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From an address on the fire resistance activities of the Bureau of Standards given before the Thirty-second Annual Meeting of the National Fire Protection Association, Atlantic City, May 9, 1928. At the request of the author, the portion relating to the severity of building fires is given in full to the exclusion of the account of the other activities. The portion here published was given also before the Fourteenth Annual Meeting of the Building Officials Conference. Articles on some of the other portions of the Bureau's fire resistance work have been given previously in the *Quarterly*, among which reference can be made to Vol. 16, No. 3, p. 255; Vol. 17, No. 3, p. 243; Vol. 18, No. 4, p. 366; Vol. 19, No. 3, p. 234; Vol. 20, No. 1, p. 60; Vol. 20, No. 3, p. 243; Vol. 21, No. 3, p. 237; Vol. 21, No 4, p. 331.

Fig. 1. Interior of the small test building (16 x 30 feet) before fire test with office occupancy. The pipes protruding through the walls and roofs are for thermocouples used in recording the interior temperatures.

applied for load carrying purposes, led me to consider the possibility of conducting burning-out tests in suitably designed structures to obtain the needed information. If such tests could be made to yield quantitative information on the equivalent fire durations to be expected with given building types and occupancies, it would help measurably to place the whole structure of fire resistance requirements on a rational basis. Fire is a contingent condition that may or may not involve a building or given portion thereof in its lifetime. In theory, at least, the owner should be required to make provision for safety to life within and near the building, and for protection to adjacent and neighboring property only as it concerns the building type and size proposed and the occupancy it is intended to house. With requirements more or less uniform for all occupancies the tendency would be to require more than the needed protection for buildings with the lighter occupancies from the fire hazard standpoint, and not enough for those with the greater amounts of combustible contents.

Test Structures and Testing Methods.

The first building erected in 1922 was a one story brick and concrete structure, 15 by 29 feet inside and about 9 feet from floor to ceiling (Figs. 1 and 2). This was fitted with discarded furniture and records to simulate an

Fig. 2. Exterior of the small test house during the fire test with office occupancy. (See Fig. 1 for interior view of this building before the fire.)

office or light commercial occupancy, a wood top floor on sleepers in cinder fill being provided in some of the tests. The fire was started either in a waste paper basket placed near one of the desks or it was given what approximated an exposure fire start by burning a quantity of oil-soaked wood kindling in a grate about three feet in diameter and seven feet high placed in one corner of the room. A metal shield around it was withdrawn when the contents were burning freely, the temperature from the resulting hot blast being above the ignition points of wood and paper over most portions of the room. Pivoted shutters in the walls were regulated to give what was deemed to be the proper amount of air for maximum fire conditions within the room. Three tests with wood furniture and records giving combustible contents inclusive of the wood floor, if present, from 13.1 to 15.4 pounds per square foot (Table 1, Tests 1, 2 and 3), were conducted in this building, also one with records on wood shelving giving 55.4 pounds per square foot (Table 1, Test 8). The tests with office and records occupancies were repeated in a larger building, 30 by 60 feet in plan (Fig. 3), with a monitor over the center section to provide opportunity for the draft conditions introduced by an open stair or elevator shaft. This room was deemed to be of a size sufficient to account for any effect on the fire severity attributable to room area. A view within this room before test is shown in Fig. 3, and one during a test in Fig. 4.

Table 1.—Results of Fire Intensity-Duration Tests with Office and Record Room Occupancies.

Test No.	Occupancy	Furniture	Finish Floor	Building	Fire Start	Amount Combustible Materials. Lbs. per sq. ft.	Approx. B.T.U. per sq. ft. of floor area	Approx. B.T.U. per cu. ft. of room volume	Equivalent Fire Duration 150° C. (302° F.) base Hr.-Min.	300° C. (572° F.) base Hr.-Min.	Curve Used
1.	Office	Wood desks, files, etc.	Wood	Small	Exposure	14.8	120,000	13,100	1-03	0-47	Average
2.	Office	Wood desks, files, etc.	Wood	Small	Slow	15.4	121,000	13,200	1-26	1-15	Average
3.	Office	Wood desks, files, etc.	Cement	Small	Exposure	13.1	105,000	11,500	1-05	0-54	Average
4.	Office	Wood desks, files, etc.	Wood	Large, East section	Slow	20.6	166,000	15,800	2-05	1-51	Average
				Large, middle section	Exposure	16.3	132,000	11,300	2-01	1-49	Average
				Large, West section	Exposure	20.2	162,000	15,400	2-04	1-51	Average
5.	Office	Steel desks, files, etc.	Cement	Small	Exposure	10.0	76,900	8,400	0-04	0-01	Average
									0-09	0-05	Upper
6.	Office	Steel desks, files, etc.	Wood	Small	Exposure	12.0	87,000	9,500	0-35	0-02	Average
									0-48	0-11	Upper
7.	Record room	Wood shelving	Cement	Large, East section	Slow	44.0	347,000	33,000	5-10	3-17	Average
				Large, middle section	Exposure	52.2	411,000	35,400	6-57	5-00	Average
				Large, West section	Exposure	49.0	386,000	36,800	8-14	6-21	Average
8.	Record room	Wood shelving	Cement	Small	Exposure	55.4	440,000	48,000	8-44	6-50	Average
9.	Record room	Skeleton type steel shelving	Cement	Small	Slow	48.5	350,000	38,100	5-15	4-40	Average
10.	Record room	Partitioned type steel shelving	Cement	Small	Exposure	49.2	333,000	36,400	5-00	3-41	Average

Fig. 3. Interior of the large test building (room 30 x 60 feet) prior to the start of the office occupancy test fire with wooden furniture on a wooden floor. This test represents about the maximum of combustible material for an ordinary office occupancy.

The fires were started at one or more points in one (east) end of this room, the large room size rendering it impractical to attempt an exposure start for the fire as was done in the smaller room. However, as it concerns the middle and farther (west) section of this room, the fire start can be regarded as equivalent to exposure from the burning of the contents of the section in which the fire originated.

Air temperatures were measured at three levels, and measurements were also made of temperatures in the débris. In the smaller room between 35 and 40 thermocouples were used for these purposes and in the other about 100.

Heat of Combustion of Contents.

Besides listing the combustible contents in pounds per square foot, the heat value of the contents is also given in Table 1 in terms of British thermal units per square foot of floor area and per cubic foot of room volume. The heat of combustion of the wood and paper constituting the contents was determined in tests on typical samples.

Reduction of Temperature Data.

From the temperatures at the different points in the room the average for the room or a given section thereof is obtained, which, together with the corresponding maximum and minimum temperatures, is plotted against time

Fig. 4. The large building during a test with office occupancy. (See Fig. 3 for interior view prior to the test.) The windows were left slightly open in order to admit sufficient air for the maximum rate of combustion.

as abscissa. The data are also reduced to show the average temperatures at the different levels. As a rule, only the average room or section temperature is used in the comparisons to obtain the equivalent fire durations. In the case of the tests with office occupancy and steel furniture, however, the average temperature for the upper level, 18 inches below the ceiling, was also used.

The standard furnace exposure curve used generally in American fire testing practice, together with cooling curves obtained from temperature measurements of our furnace chambers after the fire was shut off, are shown in Fig. 5. There is also given in Fig. 5 the average temperature curve from one of the burning-out tests. An approximate comparative measure of severity is obtained by assuming that the area under the latter curve, expressed in degree-hours, gives severity equivalent to an equal area under the standard exposure curve and the cooling curve applicable for the given period. The assumption that equal areas under time-temperature fire exposure curves stand for equivalent severity of exposure is an approximation only, since in the heat conductivity equation applicable for the case the exposing temperature enters directly as a factor in the expression for the temperature obtaining at any point within an exposed body, while the time, which is the other factor in the time-temperature area, enters as an exponent. However, we have so far found no better measure of comparison that can be conveniently applied. It might also be noted that temperature transmission through materials is retarded not only by the heat insulating properties present, but also by calcination effects and evaporation of free and combined water, and it appears

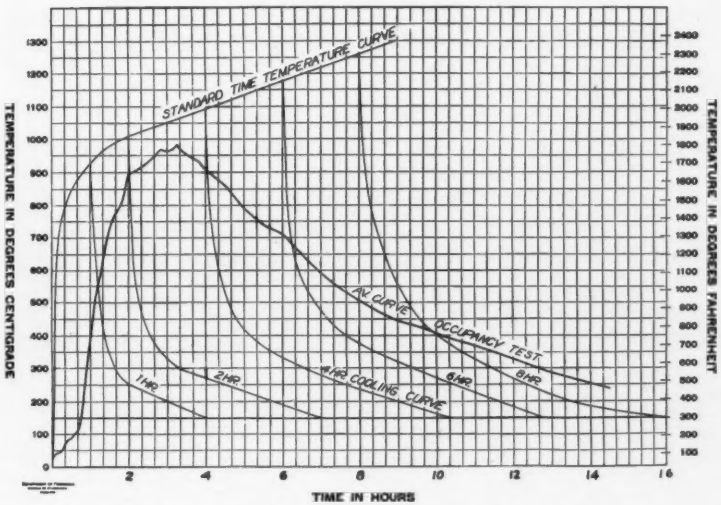

Fig. 5. Standard time temperature curve used in furnace fire tests, cooling curves, and curve representing the temperatures in a typical occupancy test.

probable that the effect of the fire exposure in breaking down resistance of the latter type is also measured approximately by the product of exposing temperatures and the time they prevail.

Another point that must be considered in making such comparisons is the minimum temperature that need be considered as an exposing temperature. For the results reported in this paper 150° C. (302° F.) and 300° C. (572° F.) have been taken as base lines and only the areas of standard and occupancy test curves above these lines are considered significant. The former is below the ignition points of ordinary combustible materials and it would not in any general case appear necessary to take into account lower temperatures, even considering that temperatures somewhat higher than the average room temperatures used in the comparison obtain in portions of the room. Where only protection for incombustible structural members is involved, temperatures below 300° C. (572° F.) can probably be neglected where the fire exposures are of the relatively short durations incident to fires in buildings.

To make convenient the determination of equivalent durations from burning-out tests, the area to a given base line under the standard furnace curve plus cooling curve, expressed in degree-hours, is plotted against time as abscissa. The area to the same base line of the time-temperature curve from the occupancy burning-out test considered is obtained in the same unit and the equivalent duration of the latter can be read directly from the area-time curve of the standard furnace test.

Details of Tests and Results.

All tests made from which results were obtained in the form of equivalent fire durations are given in Table 1.

Office Occupancy, Wood Furniture.

As previously indicated, three tests of office occupancy with wood furniture were made in the small structure, and a similar one with somewhat larger amount of combustible content in the larger building (Table 1, Tests 1, 2, 3 and 4). As it concerns equivalent fire durations, the results of the latter test are reported separately for each of three 20-foot sections in the 60-foot long structure.

These fires resulted in complete burning of contents including the wood finish floor where present. Time-temperature curves from one test are shown in Fig. 6. After temperatures high enough to cause ignition and rapid combustion of contents had been built up, the average room temperature for tests in the small building rose to maximums between 810 and 970° C. (1490 to 1778° F.) in about 20 minutes, and to maximums between 940 and 1025° C. (1724 to 1859° F.) in about one hour for respective sections in the large building. For the tests in the small building these temperature rises were more rapid than those of the first period of the standard fire test, and for those in the large building they were less rapid than in the standard testing procedure. After the maximum the temperatures fell more slowly in all tests than in test furnace chambers after the fire is shut off. The equivalent dura-

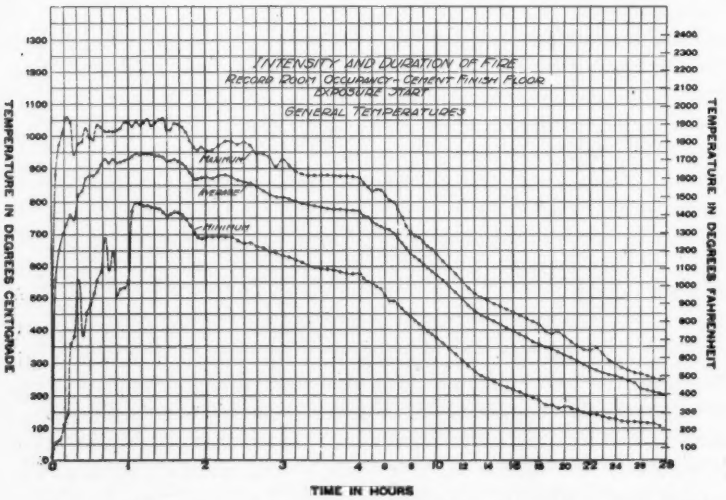

Fig. 6. Maximum, average and minimum time temperature curves from record storage test with wood shelving in small test house.

Fig. 7. The interior of the small test house representing a typical office occupancy with metal furniture on a cement floor. The exposed papers are intended to represent the probable maximum of exposed material in an occupancy of this character.

tions (Table 1) derived according to the methods outlined above ranged from 47 minutes to 1 hour 26 minutes for tests in the small building having combustible contents from 13.1 to 15.4 pounds per square foot, and from 1 hour 49 minutes to 2 hours 5 minutes for the different sections in the test in the large building having combustible content from 16.3 to 20.6 pounds per square foot. The larger room area gave a little greater severity than would be expected from the results of tests in the smaller room even after allowing for the difference in amounts of combustible contents present. The fire in the end sections of the large building apparently affected the temperatures in the middle section to such extent as to give it nearly the same equivalent fire duration in spite of the lower content. The vent over the middle section induced air currents that undoubtedly aided in equalizing the room temperatures.

Office Occupancy, Metal Furniture.

The tests of office occupancy with metal furniture were conducted in the small building, the furniture consisting of desks, tables, filing cabinets and shelves similar in number and disposition to what was present in the tests with wood furniture (Fig. 7). The total amount of records was, however, greater by about 25 per cent, and about one-half of it was placed on top of tables or in open shelves or cabinets. With cement finish floor no room temperatures

Fig. 8. Interior of the small test building after a fire test with office occupancy, metal furniture on cement floor. This was an "exposure" fire test, the rack in the right background of the picture being filled with kindling wood surrounded with a shield which was drawn back after it was burning briskly, thus simulating the conditions of an exposure fire.

above 104° C. (219° F.) developed when fires were started from burning contents of waste paper baskets. The fire was confined to contents of open shelves and other exposed paper adjacent to the point of origin. With wood finish floor and a start for the fire in a pile of waste paper, contents of adjacent open shelves and of filing cabinets under which the floor burnt out, were wholly or partly consumed. The progress of the fire was very slow, eight hours being required before 30 per cent of the floor was consumed. The maximum room temperatures at the different points ranged from 50 to 230° C. (122 to 446° F.), and except for the slow fire in the finish floor no general spread of fire occurred.

Two exposure starts for the fire were staged, one with a cement-finish floor and one with a wood top floor. (Table 1, Tests 5, 6.) In the former exposed paper over about two-thirds of the room was ignited by the blast from the grate, but no general fire condition involving the room contents developed. Temperature maximums from 55 to 808° C. (131 to 1486° F.) were recorded for different portions of the room, most of the heat developed being from the fuel in the grate. At the end of thirty minutes the temperature maximums were generally below points causing ignition of combustible mate-

rials. The highest equivalent duration obtainable from this test was nine minutes, which was obtained from the curve for the upper level, 18 inches below the ceiling.

After the exposure start with wood finish floor, about the same extent of initial spread of fire occurred as in that with cement-finish floor. The fire in the wood floor progressed more rapidly than with the slow start for the fire, being about 20 inches from the opposite end of the room at four hours, when the fire was put out. Average room temperatures above the ignition point of paper obtained for most of this period. The equivalent fire durations (Table 1) range from two minutes to 48 minutes, depending on the base line and the temperature curve taken.

Record Room Occupancy, Wood Shelving.

One test was conducted in the large building with records on wood shelving, the combustible weight being from 44 to 52.2 pounds per square foot, assumed uniformly distributed. (Table 1, Test 7.) This followed a previous similar test in the small building with records and shelving weighing 55.4 pounds per square foot. (Table 1, Test 8.) The latter was given an exposure start from the grate, the equivalent durations being longer than for any other test. The results for the east section of the large house cannot be considered fully valid on account of the irregularities involved in starting the fire from a single small origin in this section. The wood shelving in these tests collapsed within one hour after the fire was burning freely, precipitating the paper contents in a mass which burned slowly. The equivalent fire durations of these tests vary from 3 hours 17 minutes to 8 hours 44 minutes, according to conditions obtaining. (See Table 1.)

Record Room Occupancy, Metal Shelving.

The long equivalent durations obtaining for the tests with records on wood shelving prompted inquiry into methods whereby the hazard can be reduced, which led to tests with metal shelving. The results with wood shelving indicated that the building members adjacent to such concentrations would require heavier protections than those for the portions of the building housing the regular office occupancy as such. Inasmuch as these concentrations may occur anywhere within the building, the general design would have to take them into account if fires completely consuming them, without any fire extinguishment, are to be assumed.

The tests with records on metal shelving were all conducted in the small building, the weight of records assumed uniformly distributed being 48.5 pounds per square foot of floor area, which was the same as was present in the previous test in the same building with records on wood shelving. (Table 1, Tests 9, 10.) No wood top floor was present in any of the tests with record room occupancy. In the first tests, shelving representative of several general

Fig. 9. Steel shelving in the small test house arranged to represent a record room occupancy. The shelving shown here is of the backed and partitioned type referred to in the text.

types was introduced, nearly one-half of the records being on "skeleton" type shelves having no partitions or backs. Others had partitions but no backs, or backs without partitions, and one single depth 29-foot row had both backs and partitions with doors on two 3-foot wide sections.

The first of these tests was started with a waste paper basket fire in front of a single depth bay open at the front, but with metal back and partitions. The window shutters were opened to give the air supply deemed most favorable for fire spread, but no general fire condition resulted, the fire when put out at 7 hours 20 minutes being confined to two 3-foot sections with some charred or glowing papers in a cupboard adjacent to one of them.

The affected paper was replaced and two fires were started simultaneously in piles of waste paper placed on the floor, one in front of shelving similar to that in the first trial, and the other in front of a double depth "skeleton" row. The fire progressed more rapidly than in the first test, particularly in the open shelving, and at the end of $1\frac{1}{2}$ hours the whole room was involved. Collapse of skeleton type shelving began at this time and eventually involved all of the shelving that did not have partitions. All combustible contents of the room were completely consumed, the equivalent duration of the fire being 5 hours 15 minutes as derived for the 150° C. base, and 4 hours 40 minutes for the 300° C. base.

Fig. 10. Interior of the small test house after the fire test with record room occupancy shown in Fig. 9.

The room was fitted with new shelving, mainly of the backed and partitioned type with doors every third bay (Fig. 9). Three double sections of well-braced skeleton type shelving were also included. In one test, with a slow start for the fire made in a manner similar to that of the first test described above, the fire progressed laterally through a 3-foot wide cupboard section and another 3-foot wide section with open front in 20 hours, but no general fire spread resulted. A second fire in front of a double-depth open front, backed and partitioned bay spread through a closed front section on each side and involved the whole 18-foot long stack in about 9½ hours. In this test the window shutters were kept at the lowest opening, and while this retarded the fire at some stages it enabled room temperatures to be built up high enough to cause general fire spread at 13½ hours.

The room was reloaded for tests with "exposure" start for the fire, approximated as in previous tests by starting a fire in oil soaked wood kindling in the grate in one corner of the room. After withdrawing the surrounding

Table 2.—Equivalent Fire Durations for Office and Record Room Occupancies in Fire Resistive Buildings Equipped with Combustible Furniture and Shelving.

Total Combustible Content. (Inclusive of finish floors and trim.)		
Lbs. per sq. ft.	Assumed B.T.U. per sq. ft.	Equivalent Fire Duration Hrs.-Min.
10	80,000	1—00
15	120,000	1—30
20	160,000	2—00
30	240,000	3—00
40	320,000	4—30
50	380,000	6—00
60	432,000	7—30

shield, when the kindling was burning freely, the resulting air temperatures in most portions of the room were above the ignition point of paper for 10 to 15 minutes. While fires started at many points they did not progress, and at two hours the average room temperature was below 100° C. (212° F.). Similar results were obtained in a second exposure start. After one hour the window shutters were closed to their lowest opening and the fires, which had started in various portions of the room, allowed to go on until air temperatures high enough to cause general fire spread were built up. This required about four hours, the fire in the skeleton bays being mainly responsible for the relatively rapid temperature rise. The contents of the whole room were soon involved, the fire being quite intense but of shorter duration than in previous tests with record room occupancy. No collapse of shelving supports from fire exposure occurred during this test, most of the contents remaining on the shelves until consumed (Fig. 10). The equivalent duration of the fire (Table 1) was five hours, computed to a base of 150° C., and three hours 41 minutes, computed to the 300° C. base.

Temperatures in the Débris.

The temperatures and equivalent fire durations so far discussed are based on free air temperatures and do not consider those in the glowing or hot débris on the floor after the fire. Measurements of such temperatures were made at three or more points in the different tests. For office occupancy with wood or metal furniture these temperatures were indicated to give a more severe exposure than the air temperatures only where extra high cabinets of considerable area were present. Insulated safes having fire resistance little above one hour as referred to the standard fire test and placed closely adjacent to four-drawer wood filing cabinets in the burning out tests, satisfactorily preserved their contents. However, the depth and temperature of the débris from some of the large stacks of shelves or cupboards six feet high, present in the office occupancy test in the large house, indicated a more severe exposure than the air temperatures developed. The depth of the débris and duration of high temperatures were even greater for record room occupancy and wood shelving, average temperatures of 300° C. (572° F.) or over obtaining for

periods up to 16 hours. For the test with records on skeleton type shelving that collapsed, the débris temperatures indicated a condition only slightly more severe than the air temperatures, and for the last test with steel shelving that did not collapse, the débris or floor temperatures gave a duration about the same as that for the air temperatures as computed for the 150° C. base, and very much lower (one hour 46 minutes) for the 300° C. base.

While these temperatures indicate the desirability of not placing safes and similar containers in close proximity to high concentrations of combustible materials, the heat effects from the débris will be mainly on the floor construction. Since, as a rule, there are no combustible materials or finishes on the under side of the floor construction, higher temperatures can be permitted than for walls and partitions protecting combustible materials in contact with the unexposed side. This consideration, together with the fact that water will generally be applied on the débris from such concentrations, apparently justifies the basing of fire resistance requirements on the fire durations derived from measurements of the air temperature of the room rather than from those of the débris.

Summary and Conclusions.

The equivalent durations given in Table 2 for assumed amounts of combustible contents are based on the results given in Table 1 for office and record room occupancies employing wood furniture and shelving. The periods given are intermediate between those obtaining for the 150 and the 300° C. base, being possibly a little closer to the former than the latter. The periods for the 30 and the 40 pounds per square foot combustible content are derived by interpolation between the results with office occupancy on one side and with record room on the other. There is also a little extrapolation involved in connection with the periods for the 10 and the 60 pounds per square foot floor load. The heat of combustion of the contents is taken at 8000 B.T.U. per pound up to 40 pounds per square foot combustible content, beyond which it is decreased to 7600 and 7200 B.T.U. per pound for the 50 and 60-pound floor load, to allow for the relatively greater amount of paper entering into the contents.

To judge by the trend of the experimental data, the one hour equivalent duration for 10 pounds per square foot combustible content is a little higher than indicated by the tests. The periods for the 15 and 20-pound load are, however, near the average of experimental values. The small margin for the lowest period is considered desirable, since with low room contents the increase in severity from exterior exposure and similar fire effects would be relatively more pronounced than for rooms with a greater amount of combustible contents. The periods as they stand contain, however, an element of exposure of the amount obtainable from the equipment used to produce an exposure start for the fire in the tests. The periods given in Table 2 for 50 and 60 pounds per square foot content may appear a little low as judged by

Table 3.—Equivalent Fire Durations for Office and Record Room Occupancies in Fire Resistive Buildings Equipped with Incombustible Furniture and Shelving.

Occupancy	Furniture	Finish Floor	Total Combustible Content (Inclusive of any wood floor and trim)		Equivalent Fire Duration
			Lbs. per sq. ft.	Assumed B.T.U. per sq. ft.	Hrs.-Min.
Office	Incombustible filing cabinets, desks, shelves	Incombustible	10	74,000	0—10
Office	Incombustible filing cabinets, desks, shelves	Combustible	12	91,200	0—30
Record room	Incombustible open shelving	Incombustible	50	350,000	5—00
Record room	Incombustible partitioned and backed shelving	Incombustible	50	350,000	4—30

the weight of contents alone. In the tests with records on wood shelving the contents were mainly old government account records on grades of paper that had a higher fuel value than can be premised for the paper that generally constitutes the contents of record rooms. Hence in Table 2 a somewhat lower B.T.U. value is assumed for the contents than obtained for the paper in the tests with record rooms, and on the basis of these assumed values the equivalent durations given will be found to accord with the results of the tests.

The periods for office and record room occupancies with metal furniture and shelving given in Table 3 are obtained directly from Table 1, from the tests with comparable equipment and combustible contents. For office occupancy with cement finish floor the value in Table 3 is a little above the maximum obtaining at the upper level in the burning out test with exposure start for the fire. The other periods are chosen to include an allowance for exposure start for the fire comparable with what was done in deriving the periods in Table 2.

The methods by which concentrations such as from record rooms and libraries can be provided for in the design of office buildings will depend on the occupancy and equipment limitations that can be applied. Where such storage can be segregated in designated portions of the building the necessary protection can be incorporated in or applied to the surrounding building members or constructions at relatively low cost. Where this cannot be done, and the concentrations are allowed anywhere within the building in amounts occupying some 200 or more square feet of floor space, the general design of the building would have to take this potential fire condition into account. The hazard can be reduced to the point where it would require no protection above that required for the regular office occupancy, by housing combustible contents where they exceed an amount approximating 20 pounds per square foot, in fully enclosed shelves or cabinets of metal or other incombustible materials.

Application to Other Occupancies.

The equivalent fire durations summarized in Tables 2 and 3 apply in the main to light commercial, office or record storage occupancies where the com-

bustible materials are principally wood and paper. The extent to which the results of these tests can be applied to other occupancies depends on the character of the combustible materials housed and their calorific values as compared with those for wood and paper. In Table 4 are given the calorific values for most materials or material-forming substances that are housed in buildings. These were compiled mainly from the literature extant on the subject. Determinations were made on wood and paper present in the tests and on some fibrous organic materials. In addition to the calorific value, the readiness with which a given material burns would also have to be considered. It is intended to conduct some tests in the near future to obtain information on the effect of such variations on resulting equivalent fire durations. It will be seen from the table that a considerable range of materials have calorific values within the range given for wood and paper. It appears probable that for occupancies housing such materials and possibly for some that have properties outside of this range, but with burning properties not too far different from wood and paper, a fair approximation of the equivalent fire durations to be expected can be obtained by applying the B.T.U. values and corresponding equivalent fire durations given in this paper.

Table 4.—Calorific Values of Materials.

Substance	Moisture per cent	Calorific value B.T.U. per pound	Ref.
Coals			
Anthracite (Pa. only)	2.3– 2.2	12,520–13,830	1
Semi-anthracite (Pa. only)	3.4– 3.2	13,120–13,380	1
Semi-bituminous	2.4– 2.0	13,710–14,810	1
Bituminous	14.2– 1.6	10,020–14,700	1
Sub-bituminous	20.5–13.5	8,690–11,140	1
Lignite	43.5–32.6	5,810– 7,360	1
Peat	90.3–54.7	510– 4,100	1
Cannel coal	1.5– 0.4	10,850–15,000	1
Coke	0.2– 0.1	11,690–12,810	1
Charcoal	3.2	12,920	1
Woods			
Ash	Dry	8,480	5
Beech	13	7,510	11
Birch	12	7,580	11
Elm	Dry	8,510	5
Fir	Dry	9,060	5
Hardwood (av. several species)	10.8	8,120	6
Locust	**	8,640	3
Oak	13	7,180	11
Pine	12.3–10.5	8,080– 8,420	6
Soft wood, resinous	10.4	8,330	6
Straw			
Buckwheat	Dry	5,590	7
Flax	Dry	6,750	7
Wheat	Dry	6,290	7
Tanbark	Dry	9,500	10
Bagasse	53	3,910	7
Petroleum products			
Crude and fuel oil	*	18,610–19,710	6
Gasoline	*	19,800–20,520	6
Kerosene	*	19,710–19,890	6
Coal tar oil	*	17,890–18,400	1
Gas oil	*	19,260–19,580	3

Substance	Moisture per cent	Calorific value B.T.U. per pound	Ref.
Asphalt, pure	*	17,160	13
Bitumen, pure	*	15,140	5
Ozokerite	*	19,170–19,710	1
Paraffin	*	17,960–20,110	1
Pitch	*	15,120	4
Gas			
Natural (B.T.U. per cubic foot)	*	710– 2,250	1
Oil (B.T.U. per cubic foot)	*	510– 800	1
Coal (B.T.U. per cubic foot)	*	450– 670	1
Producer (B.T.U. per cubic foot)	*	100– 180	1
Water (B.T.U. per cubic foot)	*	300– 670	1
Cotton, combed	Air dried	7,160	6
Silk, "fiber"	**	9,230	3
Wool, raw	Air dried	9,790	6
Wool, scoured	Air dried	8,890	6
Paper (ash—7.0% to 1.4%)	5.0– 4.8	6,710– 7,830	6
Cellulose	*	7,570	8
Starch	*	7,610	8
Guncotton	**	1,900	3
Dynamite, 75%	**	2,320	3
Casein	**	10,550	12
Animal and vegetable oils			
Cod liver	*	16,980	1
Lard	*	17,010	1
Menhaden	*	16,850	1
Shark	*	16,870	1
Sperm	*	17,900	1
Whale	*	17,050	1
Arachis	*	16,940	1
Almond	*	17,010	1
Castor	*	15,950	1
Cotton-seed	*	16,920	3
Linseed	*	16,860	1
Maize	*	16,950	1
Olive	*	17,020	1
Poppy	*	16,890	1
Rape-seed	*	17,080	1
Sesame	*	16,910	1
Fats and waxes			
Animal fats, mean	*	17,100	2
Butter fat	*	16,770–16,850	1
Goose fat	*	17,110	1
Lard	*	17,110–17,380	1

*Moisture free or pure substances assumed.
**Moisture content not stated.

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7. Kent's Mechanical Engineers' Pocket Book.
8. Berthelot.
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15. Roth.

Substance	Moisture per cent	Calorific value B.T. U. per pound	Ref.
Oleomargarine	*	17,280	1
Tallow	*	17,100	12
Stearic acid	*	16,870	12
Chemicals			
Carbon, graphite	*	14,540	14
Hydrogen	*	61,060	15
Sulphur	*	4,000	14
Acetylene	*	20,750	9
Amyl alcohol	*	16,120	14
Benzene	*	18,050	12
Benzoic acid	*	11,390	6
Carbon disulphide	*	6,130	8
Ethyl alcohol	*	12,930	14
Ethyl ether	*	22,000	2
Ethylene	*	21,340	14
Glycerine	*	7,770	12
Methyl alcohol	*	9,550	14
Naphthalene	*	17,320	6
Sucrose (sugar)	*	7,110	6

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Fire Test of Brick Joisted Buildings.

A full scale fire test, unique in the history of fire protection engineering, was conducted in Washington, D. C., at 5:30 A.M. on June 17, 1928, when two brick joisted buildings were ignited and allowed to burn without the application of water. This test, which was in the nature of a continuation of the fire test activities of the U. S. Bureau of Standards described in the article on page 43, was for the purpose of determining the actual fire behavior of brick joisted buildings of this character as compared with the assumed fire conditions of the standard time-temperature curve, and to gain further knowledge of the behavior of fire-resistive safes and other record containers in buildings where the structure collapses during a fire. This test was conducted under the direction of Mr. S. H. Ingberg (Member N.F.P.A.) and was arranged in coöperation with the N.F.P.A. Committee on Protection of Records, a meeting of the committee being held in connection with the test.

The buildings burned were located near the corner of 10th and B Streets, North West. The entire block was being razed in connection with the government building program, the two structures burned being left for the purpose of the test. In this way it was possible at a moderate expense to conduct a burn-out test which would have involved a prohibitive expense if it had been necessary to erect structures especially for the purpose of the test.

Construction of the Buildings.

The two buildings were of brick, open-joisted construction, respectively five stories and two stories high. Neither building had a basement, the walls resting on heavy concrete slabs at the ground level. The five-story building was 75 feet long and 30 feet wide, with an open elevator shaft and open stairway. The floors were of the ordinary joisted type with one-inch flooring. There were few partitions and nothing to obstruct the rapid spread of fire through the structure. The walls of this building were of well-laid brick, somewhat thicker than is now called for by standard practice for buildings of such height.

The two-story building was of similar construction, 20 feet by 75 feet, also with an open stairway and elevator shaft.

Owing to the razing of the adjacent structures and an open market space across the street, there was a clear space of several hundred feet in every direction around the buildings which were burned. The test was deferred until weather conditions were propitious, for if there had been a high wind the surrounding buildings might have been endangered. Very careful precautions were taken to protect surrounding buildings. A large detachment

Photo by John C. Knight (Member N.F.P.A.)

The two adjoining buildings used for the Washington fire test conducted by the U. S. Bureau of Standards.

of the Washington Fire Department was present and laid down a water curtain around the entire block to absorb the radiated heat.

The buildings were loaded with waste lumber and similar material to represent a combustible occupancy such as might be encountered in an office or mercantile building. Waste lumber was largely utilized for this purpose, care being taken to place no wood in the building of smaller dimension than one-inch boards, in order to minimize the danger of flying brands. In the front portion of the larger building the load of combustible material amounted to approximately 7½ lbs. per sq. ft. of floor area. In the central section there was a greater amount of waste lumber used, making a combustible content of 15 lbs. per sq. ft, and in the rear section the combustible content amounted to 30 lbs. per sq. ft. The smaller building was similarly loaded with combustible material. Distributed throughout the buildings were some thirty odd record safes of various types, placed on all floors in positions to simulate their location in an ordinary office or mercantile occupancy.

Both buildings were provided with sheet metal roofs, the larger structure having been reroofed with sheet metal especially for the purpose of the test in order to retard the generation of flying brands which it was felt might endanger other buildings in the vicinity. The walls of the five-story building were tied together by a number of 1¼-inch steel tie rods installed above the roof for the purpose of delaying the collapse of the walls, which were expected to fall outward owing to the expansion of the interior surface when subjected to the heat of the fire. Both of these precautions apparently performed their designed functions.

Photo by R. E. Wilson (Member N.F.P.A.)

Typical interior view of five-story building, showing waste lumber placed to represent combustible contents, and safe located against wall.

Temperature Recording Apparatus.

Something over one hundred thermocouples were distributed in various parts of the buildings for the purpose of recording the temperatures at various points. Particular attention was given to the temperatures just above the floors and in the débris where safes and other record protection devices would be exposed. The leads from these thermocouples were conducted to a small fire-resistive structure in the rear of the test buildings, where readings were recorded throughout the fire and the subsequent cooling period. Some of the thermocouples were lost when the walls collapsed, but the great majority of them maintained their integrity throughout the period of the test. Provision was made for recording the temperatures inside of safes by means of especially prepared maximum indicating thermometers. Inside each such safe on the upper floors there was a clock mechanism designed to stop when the safe fell, thus recording the time of falling.

The Start of the Fire.

About 5:30 A.M. on Sunday, June 17, the contents of both buildings were ignited on the ground floor. This time was chosen both because of favorable weather conditions and the necessity of conducting the test at some time when there would not be any undue interference with traffic or business in the vicinity. In each building the fire was started at several points simultaneously, a few gallons of kerosene being used for the purpose. This represented an extreme condition as far as the rapidity of the start of the fire was concerned, but one which might be met in an actual fire in the case of some highly combustible occupancy or where flammable liquids were used. Owing to the

Photo by Hugh Miller.

The fire, started on the ground floor, spread rapidly up open stairway and elevator shafts. This picture shows the conditions during the period from ten to twenty minutes after the start of the fire. (See also Frontispiece.)

substantial fire wall between the two buildings, the initial portion of the test can be considered as two separate fires. These were started simultaneously, however, and appeared to the spectators practically as a single fire. Within about four or five minutes after ignition the fire had extended to the top story of the five-story building through the open elevator shaft, and the entire contents of both buildings were soon involved. In the course of 15 to 20 minutes the wooden floor joists began to burn through and the safes began to fall. The greater number of safes fell in the period between 23 and 38 minutes. When the fire had been burning about 28 minutes a section of the front wall fell out. Portions of the other walls fell at intervals thereafter, the greater portion of the walls above the first story having collapsed by three-quarters of an hour after the start of the fire. When the side walls of the five-story building fell out, the falling brick work blanketed the two-story structure, apparently retarding its further burning and producing a prolonged heat exposure for the buried safes. After an hour and a half or two hours it could be said that the buildings were burned down, but there remained a large mass of blazing refuse left from the collapse of the five-story building which continued to burn for many hours. It appears that the safes buried in this burning wreckage received a very severe fire punishment, for while the temperatures in

Photo by Hugh Miller.

Collapse of front wall about twenty-eight minutes after the start of the fire. Note deflection of side walls, which fell shortly after this picture was taken.

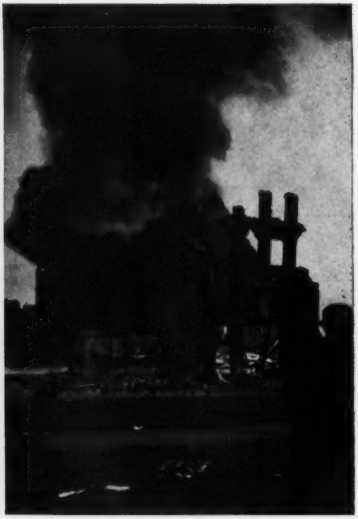


Photo by U. S. Bureau of Standards.

Falling of a major portion of the side wall. This photograph was taken about fifteen minutes after the left-hand picture.

the ruins were doubtless considerably lower than those recorded as air temperatures when the fire was at its height, the heat continued for a long period, giving a severe "soaking effect" to the safes.

Results.

This fire test involved a tremendous amount of work in preparation, and owing to the extent of the test, the numerous temperature and other observations which must be verified and compared, it will doubtless be some time before the complete report can be released by the Bureau of Standards. Some interesting observations may be drawn from this test, however, prior to the publication of any official report thereon. It appeared to the spectators that the fire generally, as far as it concerns the portions of the buildings above the débris, could not have been more severe than the first 1½ or 2 hours of the standard fire test, and possibly considerably less for the lightly loaded portions of the buildings. This estimate is necessarily subject to correction when the temperature data from the test become available. The temperature rise during the initial portion of the test was more rapid than in the standard furnace test, preliminary data supplied indicating temperatures exceeding 2000° F. at several points within 20 minutes, and maximums at a few points between 2200° and 2400° F. as obtaining within 40 minutes. After collapse of roof and floor construction, the air temperatures fell rapidly except at

Photo by R. E. Wilson (Member N.F.P.A.)

The major portion of the walls had collapsed when the fire had been burning three-quarters of an hour.

points immediately above the burning débris. The exposure in the ruins, however, was more prolonged, although less intensive. Temperatures high enough to be prejudicial to the fire safety of the contents of the safes in different portions of the ruins obtained for periods from a few hours to three days after the start of the fire. A cursory view of the ruins indicated that the severity of exposure to different safes varied greatly, even in places where the safes were within a very few feet of each other in the ruins. It appears that owing to these chance conditions the temperatures and duration of exposure varied materially at different points in the ruins, thus indicating the danger of attempting to draw conclusions as to the severity of any fire from the behavior of any individual safe, or device or material observed at a single point in the ruins.

It is expected that the test will yield quantitative data among others on the following points:

(1) the rapidity of spread of fire in open joisted buildings of the type tested;
(2) the rate of temperature rise and maximums obtaining before the interior construction collapsed as measured by thermocouples within mountings of size comparable with those employed for furnace temperature measurements in fire tests;
(3) the extent to which the rapid temperature rise produced explosive opening of safes, as has been experienced in some fires;
(4) the time the safes dropped, this to be considered in comparison with the one-half hour or one hour duration of fire test before impact drop in the standard procedure for testing safes;

(5) the effect of the drop on the safe structure, and also the effect of impact from falling brick walls and similar heavy objects, this to be considered in comparison with the effect of the 30-foot drop on brick rip-rap in the specification test for safes;
(6) the effect on safe and contents of being covered, partly covered, or in contact with the hot débris after the fire;
(7) the percentage of safes involved that were fully covered, partly covered, in contact with, or clear of the hot débris;
(8) air temperatures above the débris, this having a bearing on exposure to safes, and to party and fire walls;
(9) temperature in the débris until cooling down, a matter of several days;
(10) effect of the fire in producing collapse of building, details such as enclosing walls and metal roof covering, the protection afforded neighboring buildings by these details, and general hazard to surroundings created by the fire.

A Hospital Film Fire.

On Saturday, March 17, 1928, at about 4:30 P.M., a fire was discovered in the Memorial Hospital at Albany, N. Y. It occurred in a small room on the first floor used for the storage of films and X-ray equipment. In this room, on wooden shelves around both sides and above the entrance, were stored exposed films packed in ordinary cardboard boxes.

The cause of the fire is undetermined, although a very thorough investigation has been made by several authorities. No one, according to the best information available, had visited the room within a half hour of the time of the discovery of the fire, and the last employee to visit the room declares emphatically that he was not smoking and that everything appeared to be in order when he left.

Efforts were made by the employees to fight the fire, but they were unsuccessful, and fumes from the burning films forced their retreat. In leaving the fire the employees, in their haste and excitement, failed to close the doors between the corridor leading from the film room and the main hallway, in which are the open stairs leading directly to the upper floors. This allowed the smoke and fumes to permeate the building.

By this time the nurses had removed the patients on the affected floors, by the fire escape on the south end of the building and by the elevator, which was kept in operation practically throughout the period of the fire. Several patients refused to be moved and in such cases the doors were kept closed and the windows opened, with the result that the effect from the gas was almost negligible.

Considerable excitement existed. Many patients were taken from the building by firemen by means of extension ladders, and two persons, a

maternity patient on the fifth floor and a student nurse on the fourth floor, jumped into life nets below. Neither of them suffered any serious injury. The nurses in the Maternity Ward removed five infants and two mothers to safety by means of the fire escape. They endeavored to go back for the other mothers but were not permitted to do so.

The press reported eight deaths between the night of the 17th and the 19th. It has not been possible to find out definitely how many of these were due to the fumes. At least one was due to exposure and heart attack resulting from shock, and it is said that three or four were directly due to the effect of the smoke and fumes from the burning films.

Due to the fire-resistive character of the building, the fire itself was confined to the room of origin and all the damage was caused by the smoke and gas. Had the door been self-closing, had automatic sprinklers been provided, and had there been a proper vent to the outside of the building as provided by N.F.P.A. regulations, it is probable that the entire loss would have been confined to this room.

Studying Airplane Fires.

With the impending rapid development of aircraft and the extension of their use as commercial and pleasure vehicles, studies that the U. S. Army Air Corps has been making of airplane fires are of great value. For the past three years the Equipment Section of the Matériel Division of the Air Corps has been engaged in an original research into the cause and prevention of such fires at Wright Field, Dayton, Ohio, under the direction of O. E. Stutzman, one of the engineers of the Section. While the researches have been made from a military viewpoint, on military type planes, and the conclusions drawn on the basis of what is practical for military flying, the results show how to lessen the chance of fire from the exhaust stacks and ignition systems, and suggest structural provisions and extinguishing systems to retard the spread of fire in airplanes and to facilitate its control.

When these researches were started, statistics to show the fire hazard of Air Service airplanes were compiled, all available reports of army crashes being collected, with the following results:

Year	1921	1922	1923	1924
Reports received	131	92	158	179
No. persons in accidents	202	164	262	298
No. fatalities	36	32	31	30
No. fires in air	1	1	2	0
No. fires after a crash	14	18	10	9
No. fatalities in fires following crashes	16	22	13	13

Complete figures have not been compiled for later years, due to the considerable labor involved. In 1927 there were some ten fires reported in army planes, with nine fatalities and two injuries. Most of these fires occurred, however, *in the air*. These figures emphasize the importance of the contemplated studies, and the recent figures have justified the continuance of the work.

Early Fire Prevention Measures.

Early fire prevention measures included attempts to place the fuel tanks other than in the fuselage of the plane, to do away with electric starters, to use aluminum manifolds, to provide a fire wall between the power plant (engine, etc.) and the pilot's compartment, and to provide some sort of fire extinguishing system. Most of these measures proved unsatisfactory or

The data used in the preparation of this article, and the accompanying photographs, were furnished through the courtesy of the U. S. Army Air Service, Matériel Division, Wright Field, Dayton, Ohio.

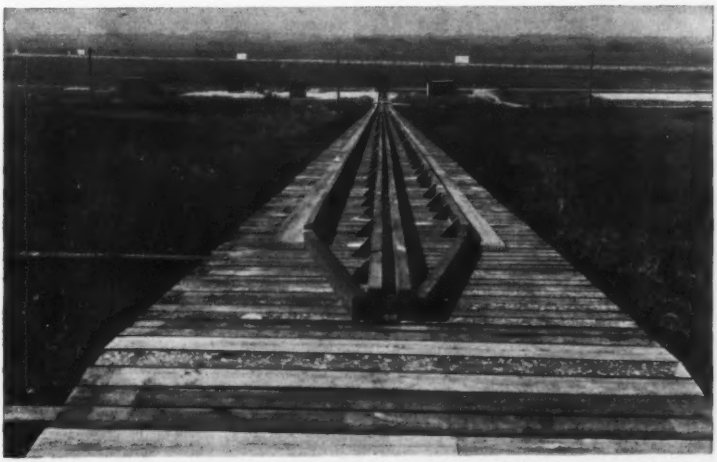
undependable. The placing of fuel tanks in the wings, or underslung on the landing gear, reduced the manoeuverability and speed of the plane, and lessened the longitudinal stability in some cases. Further research along these lines has been, however, recommended, especially with regard to the development of tanks which may be dropped before a crash. No reliable substitute for electric starters could be developed, and aluminum manifolds proved impractical because of the heat, expansion and gas pressures to which they were subjected.

Fire walls, on the whole, proved to be useful. In connection with these walls a crude extinguishing device was tried out without much success. It consisted of two flat glass flasks, each containing two quarts of carbon tetrachloride, which were supposed to break in a crash and flood the engine compartment, thus controlling any fire there.

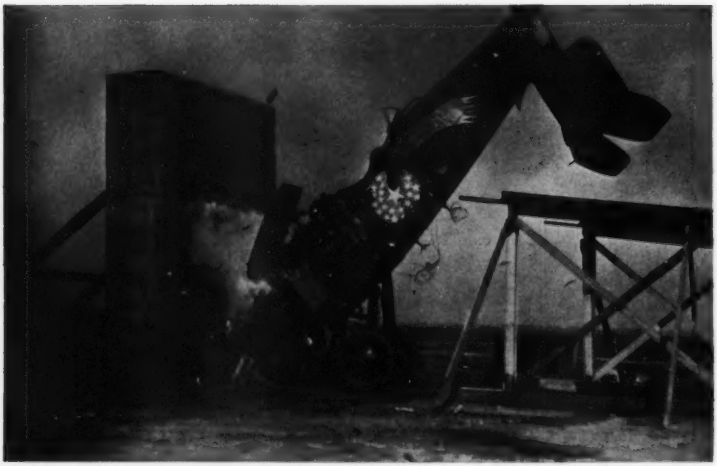
Studying Airplane Crashes.

The first need was adequate data as to how fires started in airplanes, especially following crashes. A set-up was therefore constructed, so that crashes could be produced under conditions that could be observed and analyzed.

The accompanying illustrations show the runway, which was built so as to precipitate obsolete and unserviceable airplanes against a concrete wall at the bottom. It was about 566 feet long, the upper 360 feet being at a grade of about 4.85 per cent, with a difference in elevation of about 20 feet between the ends. The wall at the bottom was of reinforced concrete 10 feet wide,



A view looking down the runway built for the crash tests. The guide rails are for the landing gear wheels and the tail skid. The sheds at the bottom are for the protection of observers and photographers.



To simulate actual crash conditions the ramp at the right of the picture was installed to lift the tail of the machine just before it crashed into the wall. Here is a typical crash after this ramp was installed.

14 feet high and 3 feet thick. Shields and bomb shelters were placed in several locations near the wall for the protection of photographers and observers.

Obsolete and salvaged airplanes were procured and assembled with gasoline tanks, power plant, landing gear and other necessary equipment, but minus wings. These planes were started from various points on the runway, and when the engine had warmed up to a normal temperature they were released and allowed to crash into the wall at the bottom. This simulated the worst conditions of a crash. These crashes were carefully observed and photographed. Slow motion pictures were also taken from one side, while normal speed pictures were made on the other. By studying these under a microscope the exact place at which ignition occurred could be determined whenever fire followed the crash.

After several crashes had been made it was found that actual crashes could be better simulated by lifting the tail of the plane before impact, that being the position in which a plane normally crashes. This was accomplished by placing outriggers on the tails of the planes and a ramp near the bottom of the incline, as the illustrations show. In order that the destruction should not be too complete for observation, the planes were run only about 300 feet instead of the full length of the runway. In some of the crashes, to preclude the possibility of fire from the ignition system, the generators were removed and the batteries were mounted on the landing gear axles, where they could be knocked off by striking a stop in the runway 25 feet from the wall. In the tables below this condition is noted as "battery (destroyed)."

First Crash Series.

The first series of 26 crashes was made over a nine-month period. Six fires were obtained. The results are tabulated below.

Crash No.	Type Airplane	Engine	Exhaust Manifolds	Fuel Tanks	Gasoline Systems	Ignition System	Fire
1	DH-4B	Wright H	Short stacks	Plain	Sylphon pump	Magneto	
2	Orenco	Wright H	Short stacks	Leak proof	Sylphon pump	Magneto	
3	USD-9A	Liberty 12	Standard DH-4	Leak proof	Gear pump	Battery (destroyed)	Fire
4	Loening PW-2	Wright H	Short stacks	Crash proof	Sylphon pump	Magneto	
5	T.M. MB-6	Wright H	Short stacks	Plain	Sylphon pump	Magneto	
6	TN-6H	Wright H	12-in. stacks	Plain	Air pressure	Magneto	
7	T.M. MB-3	Wright H	3-in. stacks	Leak proof	Sylphon pump	Magneto	
8	USD-9A	Liberty 12	Standard DH-4	Plain	Gravity	Generator	
9	DH-4B	Liberty 12	Saxophone	Plain	Gravity	Battery (destroyed)	Fire
10	DH-4B	Liberty 12	12-in. stacks	Plain	Air pressure	Battery (destroyed)	
11	DH-4B	Liberty 12	12-in. stacks	Plain	Air pressure	Battery (destroyed)	Fire
12	XB-1A	Wright H	Saxophone	Leak proof	Sylphon pump	Magneto	Fire
13	Fokker DVII	Wright H	Saxophone	Plain	Air pressure	Magneto	
14	DH-4B	Liberty 12	Whirl chamber, long tail pipes	Plain	Air pressure	Battery (destroyed)	Fire
15	XB-1A	Wright H	None	Leak proof	Sylphon pump	Magneto	
16	Fokker DVII	Wright H	None	Plain	Air pressure	Magneto	
17	DH-4B	Liberty 12	None	Plain	Air pressure	Battery (destroyed)	
18	DH-4B	Liberty 12	None	Plain	Air pressure	Battery (destroyed)	
19	DH-4B	Liberty 12	None	Plain	Air pressure	Battery (destroyed)	
20	Fokker DVII	Wright H	None	Plain	Air pressure	Magneto	
21	XB-1A	Wright H	None	Leak proof	Sylphon pump	Magneto	
22	XB-1A	Wright H	None	Leak proof	Sylphon pump	Magneto	
23	DH-4B	Liberty 12	None	Plain	Air pressure	Battery (destroyed)	
24	DH-4B	Liberty 12	None	Plain	Air pressure	Battery (destroyed)	
25	DH-9	Liberty 12	None	Plain	Air pressure	Battery (destroyed)	
26	Fokker DVII	Wright H	None	Plain	Air pressure	Magneto	Fire

Type of Tanks.

Tanks referred to as "leak-proof" have a cover of rubber gum or sponge rubber on a fabric base. Such tanks are designed primarily to prevent quick leakage from a tank when punctured by a bullet. A "crash-proof" tank may, in addition, be made up of numerous small sections so that fuel will only be spilled from the broken sections, lessening the amount of fuel to burn. From the table it will be noted that there were two fires from eight crashes where such tanks were used, and four fires from eighteen crashes where plain tanks were used. These figures are inconclusive.

The pictures taken of these crashes showed, however, that the airplane must strike at a speed of about fifty miles per hour to produce a complete rupture of the rubber covered leak-proof tank, so that it was concluded that the rubber covered tanks would reduce the likelihood of fires in crashes.

Ignition Systems.

A magneto was employed in fourteen of the above crashes, two of which produced fires. One of these fires was definitely determined to have started at the end of the exhaust manifold, and the other at an exhaust port.

A crash of a DH-4 airplane equipped with standard "saxophone" type exhaust manifold. This caused the fire.

A generator alone was used in two crashes, and one fire resulted, this starting at the end of the exhaust stacks.

The ignition system was not a factor in the other ten crashes where the battery was knocked off before the crash, but there were three fires.

While it will be necessary to completely eliminate the chance of ignition from exhaust stacks before the exact fire hazard of ignition systems can be determined, the above results indicate that magneto ignition at least is not a serious fire hazard.

Gasoline Systems.

These tests are not conclusive regarding the relative hazard of the three types of gasoline systems employed: in fourteen crashes with air pressure systems there were three fires; in ten crashes with gear or sylphon pumps there were two fires, and in two crashes with gravity feed there was one fire.

Exhaust Systems—Recapitulation.

Kind of System	No. Crashes	No. Fires
"Saxophone" manifold	5	3
Night-flying manifold, long tail pipes	1	1
Individual stacks 12 inches and less in length	8	1
No exhaust stacks	12	1*
Total	26	6

This was the most conclusive evidence thus far gained. It indicated that, disregarding the ignition systems, the exhaust system was mainly responsible for the fires.

*Caught from exhaust port.

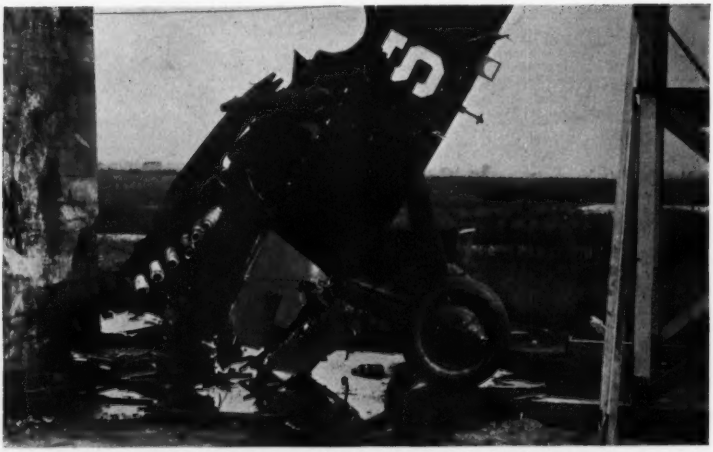
A typical crash. The cloud is of steam and gasoline vapor. No fire resulted in this case.

Second Crash Series.

It having been demonstrated that exhaust stacks caused most fires, in the next series of crashes individual aluminum air-cooled stacks 12 inches long were employed, it being known that such stacks radiated heat rapidly and were therefore much cooler than steel stacks or manifolds. Sixteen crashes were staged, with the following results. The planes used were of the DH-4B type, with Liberty 12 engines. The only leak proof tank was used in the first crash.

Crash No.	Exhaust Manifolds	Gasoline System	Ignition System	Fire
27	Saxophone	Gear pump	Battery (destroyed)	Fire
28	None	Gear pump	Battery (destroyed)	
29	None	Gear pump	Battery (destroyed)	
30	None	Gear pump	Battery (destroyed)	
31	12-in. air cooled	Air pressure	Battery (destroyed)	
32	12-in. air cooled	Gravity	Battery (destroyed)	
33	12-in. air cooled	Gravity	Battery (destroyed)	
34	12-in. air cooled	Gravity	Battery (destroyed)	
35	None	Gravity	Generator-battery	
36	12-in air cooled	Gravity	Battery (destroyed)	
37	12-in. air cooled	Air pressure	Battery (destroyed)	
38	12-in. air cooled	Air pressure	Battery (destroyed)	
39	12-in. air cooled	Gravity	Battery (destroyed)	
40	12-in. air cooled	Gravity	Battery (destroyed)	
41	12-in. air cooled	Air pressure	Battery (destroyed)	
42	None	Air pressure	Generator-battery	

In ten of these crashes the exhausts had 12-inch air cooled aluminum stacks, in five crashes no stacks at all; in none of these did fire ensue. In the one crash with a saxophone manifold there was fire. These results indicated



A crash of a DH-4 airplane with the air cooled aluminum exhaust stacks. Although the fuel and oil were scattered all about, there was no fire.

that the individual air-cooled exhaust stacks were not sufficiently hot to ignite gasoline thrown over the engine from burst tanks.

Third Crash Series.

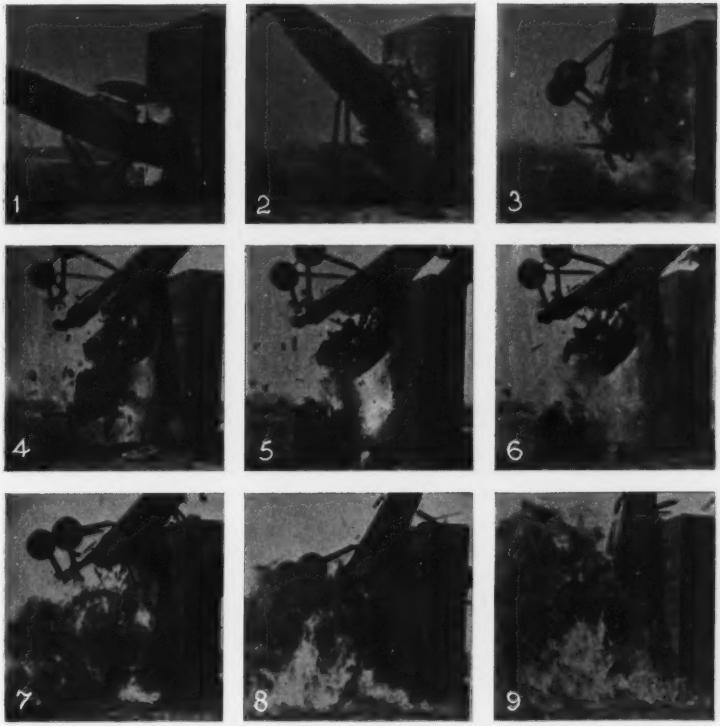
Next a series of four crashes were run on MB-3 type planes with Wright H motors. The exhausts had 10½-inch straight steel individual stacks, rubber covered tanks, gravity feed gasoline system, and magneto ignition. No fires resulted, suggesting that such steel stacks run sufficiently cool on the Wright engine to prevent ignition even though the tanks did not prevent considerable gasoline being spilled over the engine.

Fourth Crash Series.

Next a series of fourteen crashes were run off with the straight steel 10½-inch individual exhaust stacks on Liberty motors. These motors were in DH type planes, with plain fuel tanks, gravity fuel feed, and with generator battery system (battery destroyed).

Crash No.		Crash No.		Crash No.	
47	Fire	52	Fire	57	No fire
48	No fire	53	No fire	58	No fire
49	No fire	54	No fire	59	No fire
50	No fire	55	No fire	60	No fire
51	No fire	56	Fire		

This series showed that the straight steel stacks are not satisfactory for Liberty motors, all the fires starting from the stacks. In four of the fourteen crashes the motion pictures showed that no gasoline reached the exhaust stacks, and in one other case this was doubtful, so that these were not considered tests.



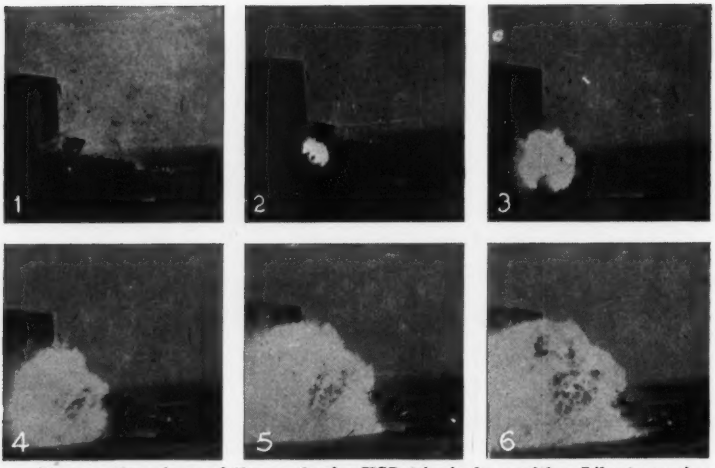
Views from a motion picture of the crash of an XB-1A airplane. Note how the power plant of the plane is disintegrated by the impact. Fire resulted from the flow of gasoline over the hot exhaust stacks.

Fifth Crash Series.

Having run a considerable number of test crashes with the ignition cut out, a series was now run off with the battery-generator systems intact upon impact. XB-1A type planes with Liberty engines were used. Exhausts were without stacks or manifolds, fuel tanks plain, and gasoline gravity feed. Out of ten crashes there were four fires.

Crash No.		Crash No.		Crash No.	
61	Fire	65	Fire	68	No fire
62	No fire	66	Fire	69	Fire
63	No fire	67	No fire	70	No fire
64	No fire				

One fire was caused by a spark struck by the motor on impact with a steel rail which had been installed as reinforcing in the wall. One fire was of undetermined origin, and two fires started in No. 1 exhaust port on the left bank of the engine. No fire could be traced to the ignition system.



Slow motion views of the crash of a USD-9A airplane with a Liberty engine. Microscopic examination of prints of these pictures makes it possible to determine the exact spot where ignition occurs. The tiny white speck in the first picture is a cloud of gasoline vapor developing. The tiny dark speck in the second picture shows the cloud of vapor igniting from a hot exhaust stack.

Sixth Crash Series.

A final series of crashes was produced to amplify the results of the preceding series. Various types of planes were used, but all had plain fuel tanks and gravity feed gasoline systems:

Crash No.	Type Airplane	Type Engine	Exhaust Manifolds	Ignition System	Fire
71	DH-4B	Liberty	None	Magneto	Fire
72	DH-4	Liberty	None	Battery	
73	French Breguet	Liberty	None	Battery	
74	MB-3	Wright	Straight steel	Magneto	
75	XB-1A	Liberty	None	Magneto	
76	XB-1A	Liberty	None	Magneto	
77	XB-1A	Liberty	None	Magneto	
78	XB-1A	Liberty	None	Magneto	
79	DH-4B	Liberty	None	Magneto	
80	XB-1A	Liberty	None	Magneto	
81	VE-9	Wright	None	Magneto	
82	MB-3	Wright	Straight steel	Magneto	
83	XB-1A	Liberty	None	Magneto	

Only one fire could be produced in these thirteen crashes. This further demonstrated that the ignition system is not a serious fire hazard, the one fire being of undetermined origin, starting nine seconds after the crash.

Ground Tests on Ignition Systems.

Night-time tests of five typical engine installations were made to see where sparks might be produced by the electrical wiring and apparatus on the

planes. In most of these tests electric sparks were produced at various points on the engine. The results are briefly summarized:

Type P-2, P-431. Curtiss engine. Spark produced between high tension wire from magneto and a ground at 1000 R.P.M. and higher. Continual flame from distributor vent. Occasional spark between No. 3 inside plug and intake manifold.

Type O-1, P-437. Curtiss engine. Constant spark between head and shell of dirty spark plug. Corona effect at end of spark plug wire conduit. Constant spark between No. 5 inside left plug and carburetor.

Type XCO-6, P-360. Satisfactory, no sparking.

Type VE-9, P-204. Vought airplane with Wright engine. Very bad, decided sparking between all wires, even low tension ones, near any grounded parts. Corona at ends of conduit between magnetos.

Type O-7, P-432. Packard engine. At high speeds distributor segment gave off sparks like a grinding wheel. Sparking between No. 2 left inside plug and a ground. Large corona around spark coil and where spark plug wires were massed. Sparks were passing between metal markers used to identify wires.

Further Tests of Exhaust Stacks.

The crash tests having proved the hazard of the exhaust stacks, further study of these was made to determine practical means of reducing the temperatures of the stacks and preventing ignition in other ways.

Water-Cooled Manifolds.

It was found that ignition could be prevented in most cases by water-cooled manifolds. A Liberty and a Wright engine were given test runs with ordinary saxophone manifolds, and either oil or gasoline injected into the exhaust end of the manifolds would ignite. When water-cooled manifolds were used there was no sign of either smoke or fire when the oil was injected. These water-cooled manifolds did not prove practical for several reasons, although numerous types were tried out. They did not reduce temperatures much beyond a safe point for one thing; they were too heavy for another; also they made too much extra radiation surface necessary. So other means of lowering exhaust stack temperatures were investigated.

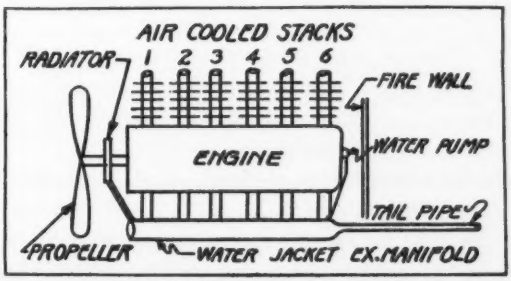
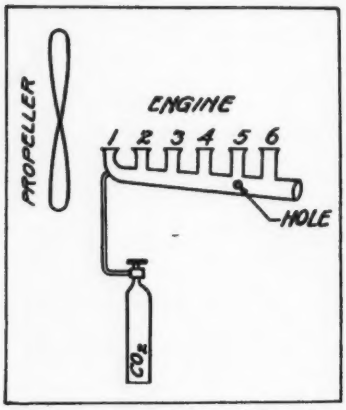


Diagram of arrangement of Liberty engine with air cooled stacks on one set of exhausts and a water-cooled manifold on the other set. This enabled comparative tests to be made on these two types of exhaust systems. Neither type would produce fires, but the air-cooled type proved to be most practical.



The arrangement by which carbon dioxide gas was introduced into the manifold. Oil and gasoline were injected through the hole shown. The CO_2 would put out the fire which followed, but did not appreciably cool the manifold. When the CO_2 was exhausted, reignition occurred.

Carbon Dioxide Gas.

An attempt was made to use carbon dioxide gas, an arrangement being made to introduce the gas in the forward end of a standard steel saxophone manifold. First the engine was run to warm up, then stopped and 8 cu. cm. of oil was injected in a hole in the manifold opposite cylinder No. 5. Fire resulted. On a second run the valve controlling the CO_2 was opened slightly, allowing a little of the gas to enter the manifold. The engine was stopped and 8 cu. cm. of oil was injected as before. Smoke, but no fire, was the result. A third run was made and oil was injected as at first, with resulting fire. Then the CO_2 was turned on slightly, putting out the fire in about three seconds. No cooling action on the manifold was noted, and very little CO_2 had been used.

Further tests were made with a small $2\frac{1}{2}$-ounce bottle of CO_2, under pressure, attached to the forward end of the manifold. The engine was run up to speed as before and then stopped. The bottle was given a blow with a hammer, releasing the CO_2. Simultaneously lubricating oil was injected into the open end of the manifold. A dense white smoke resulted, lasting till the CO_2 was dissipated. Then fire took place.

The experimenters decided to abandon this method of fire control, considering it impractical, first because of the necessary complications of any system for turning on an adequate supply of CO_2 automatically, and second because of the doubtful value of the gas under the conditions.

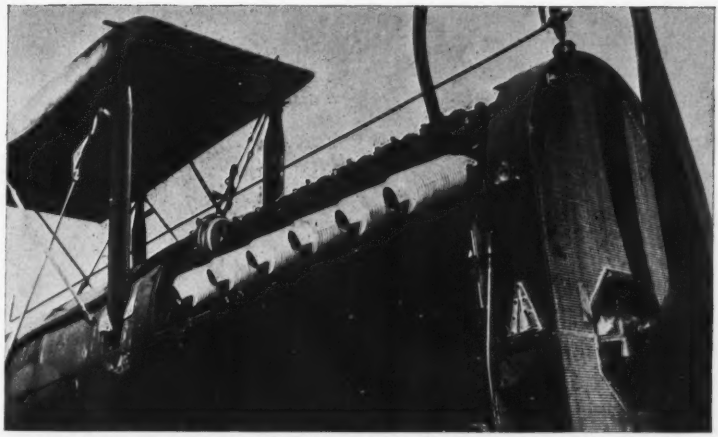
Some Other Arrangements Tried Out.

There is not space here to permit a complete description of all the other arrangements which were tried out, only to be abandoned as impractical. Some of these were, however, the following:

Standard manifold with bottle of water or carbon tetrachloride in rear to break and flood manifold on impact.

Standard manifold with an air-cooling arrangement on the end of the manifold.

Aluminum water-cooled stack in series with cooling system, open at the front end and with a long tail pipe.



A Liberty engine equipped with cast aluminum air-cooled exhaust stacks. The fins of these set ⅜ inch apart and are 4½ inches in diameter. This type of stack would not produce a fire.

Aluminum water-cooled stack similar in design to the standard manifold in series with cooling system.

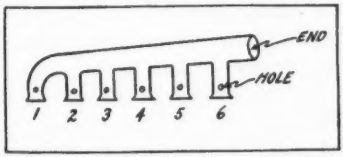
Air-cooled steel manifold with long tail pipe.

Standard manifold type, steel, open at front end.

Individual flexible steel stacks.

Air-cooled Aluminum Stacks.

From the first tests made with them, individual air-cooled aluminum stacks gave promise of being a practical solution of the stack hazard problem.

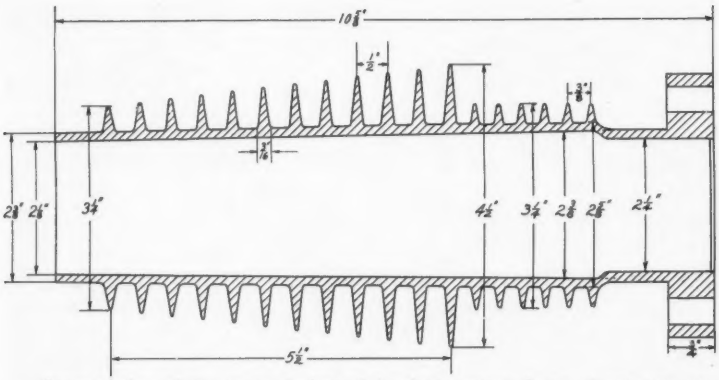


This diagram shows a standard "saxophone" type exhaust manifold such as used on a Liberty engine. Exhaust temperatures were measured by inserting thermocouples in the holes indicated.

The early crash tests demonstrated that the ordinary manifolds would cause fire at the temperatures obtained in normal operation. These temperatures measured in ground tests ranged from 1000-1400° F. If these temperatures could be somewhat reduced the probability of fire from the stacks could be greatly lessened. It was noted that even with straight steel stacks on the Wright engines the temperatures were lower than on the Liberty engines and ignition consequently less likely.

Tests were made, therefore, on various types of short exhaust stacks to study their characteristics. Some of the following types were set up on a single engine. The engine was run to be heated up, then stopped, and oil or gasoline injected into the stacks.

Twelve-inch air-cooled aluminum stacks and even straight cast aluminum stacks were apparently not hot enough to produce ignition. Straight steel



Cross-section of the type of air-cooled exhaust stack finally developed. Its maximum temperature at the end near the engine was only about 370° F., and parts farther from the engine were considerably less, dropping to about 230° F. for the last four inches.

stacks 12 and 10 inches long produced ignition nearly every time, and ignition was certain with stacks 8 and 6 inches long.

The aluminum air-cooled stacks used in these preliminary tests were made of 12-inch duralumin tubes, two inches inside diameter and ⅛-inch walls. They had 16 circular aluminum fins six inches in diameter and ⅛-inch thick welded to the tube.

It having been demonstrated that the air-cooled aluminum stack was the safest type, the next work was to develop a design that would operate at as low a temperature as possible and also be light enough. A study of the temperatures at various points on the air-cooled stack showed it to be hottest (about 1000° F.) at the end adjacent to the engine. The temperature at points an inch apart on each of three shapes of air-cooled stacks were compared. On one of these the fins were of the same diameter throughout, on the second the fins were small near the engine, increasing in diameter toward the end of the stack. On the third the largest fins were near the engine, decreasing in diameter toward the end of the stack. In each type the temperatures were highest near the engine, dropping rapidly toward the outer end of the stack. The type of stack with the larger fins near the engine gave the lowest temperatures throughout, and so was chosen. The design finally developed is illustrated herewith. It was found that the diameter of the fins could be reduced somewhat without impairing the radiation obtained. With this design the maximum temperature obtained in the short section near the engine is 370° F. From this point the temperature drops gradually, leveling off to a minimum of about 230° F. for the last four inches of the stack. It is believed that with these low temperatures the stacks will not cause fires under crash

A typical crash where fire followed. Not much chance for a pilot in a fire like this! Airports must have fire apparatus to handle crash fires of this character.

conditions. It has not been possible to ignite oil or gasoline by spraying them on these stacks when hot.

Construction of Fire Walls.

From observation on these test crashes suggestions are made regarding the construction of fire walls. These walls are generally placed just ahead of the pilot and are to prevent a fire in the engine compartment enveloping the pilot. It is recommended that the fire wall, which is made of several-ply wood, fit closely to the cowling all around the section of the fuselage, and when longerons, pipes, wires, and control members pass through it that the clearances should not be larger than necessary for assembly, and that after assembly all openings be closed with some flexible material which will delay the progress of flames. Holes through which non-movable members pass should be closed with rubber grommets, rawhide, or sheet asbestos, and, for holes through which movable members pass, rawhide is suggested. The wall should have an edge of about $\frac{1}{4}$ inch turned forward to act as a deflector for oil or gasoline, and there should be a drain through the bottom of the engine compartment instead of permitting oil and gasoline to seep through the seams into the fuselage. It is further recommended that such walls should not be painted, except when acid-proof paint may be used in the case of a battery mounted close to it.

These tests also emphasized the necessity for thoroughly ventilating all compartments, large or small, on the airplane, to prevent the accumulation of oil, gasoline or vapor, with the resulting possibility of ignition.

Extinguisher Systems.

No satisfactory fire extinguishing device has yet been developed for use on aircraft in the air. It has been customary for some time for small aircraft to carry a single 1 or 1½-quart standard carbon tetrachloride extinguisher of the hand operated type. As a result of these studies it is being recommended that the hand extinguishers be replaced by a special stored-pressure type operable from the pilot's seat, and with adequate fire fighting facilities on the ground at landing fields. It is not possible to use a hand extinguisher in the air in any case.

Encouraging results are being obtained in experiments with the stored-pressure type of carbon tetrachloride extinguisher referred to above. Standard 1 and 2-quart extinguishers are being used, the valve being controlled from the pilot's seat. The extinguishing liquid is piped to jets at various points over and around the engine, so that on being turned on it provides a sort of sprinkler system to smother any fire that occurs. Early systems of this character were unreliable, due to the vibration of the airplanes and the corrosion of their parts. These latter difficulties have been overcome in the service types now used by the Army Air Corps. Single motored planes are generally equipped with a one-quart capacity system, but where airplanes have several motors a two-quart system is installed for each engine.

It is not expected that these systems will extinguish fires in the air, but they are expected to retard combustion and, together with the fire wall, hold the fire long enough for the pilot to land. Any real fire fighting will have to be done on the ground with apparatus of larger capacity than can be carried on military planes, although commercial planes could probably carry extinguishers large enough to fight a fire on the ground after landing.

These systems are still in the development stage and much work yet remains to be done to provide some fairly satisfactory way to put out or control a fire starting in the air.

Conclusions.

The tests here described have pointed out how danger of ignition from exhaust stacks may be lessened, and the need for installing the electric wiring so that it will not produce sparks.

A complete set of recommendations and an inspection blank for airplanes is given in Air Corps Information Circular No. 572 (Matériel Division Report, Serial No. 2794) published by the Chief of Air Corps, Washington, D. C.

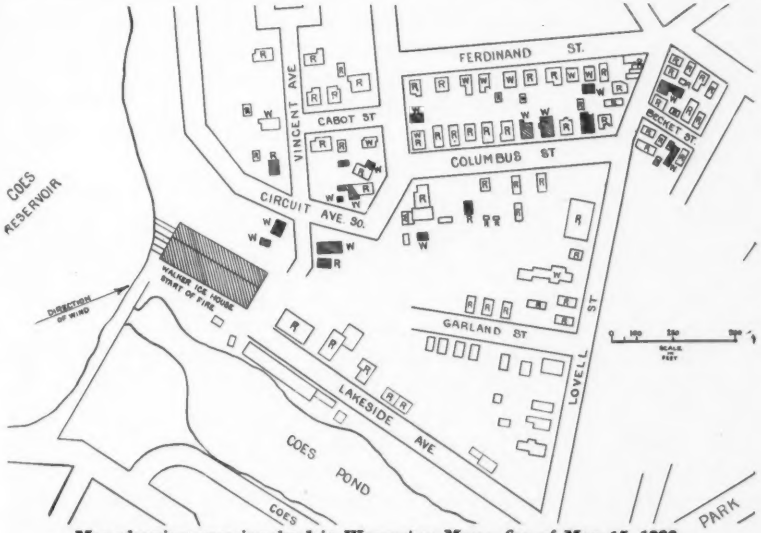
Two Interesting Wood Shingle Roof Fires.

There have been two recent fires in New England, occurring within the same week, which furnish interesting evidence as to the behavior of wooden shingles as conflagration spreaders, and clearly demonstrate the value of fire-retardant roofing. The account of the Worcester fire was made possible through the courtesy of Mr. E. L. Sanders (Member N.F.P.A.), and the data on the Concord fire were furnished by Mr. H. E. Russ (Member N.F.P.A.).

Worcester, Mass.

Fanned by a strong southwest wind, fire, Tuesday afternoon, May 15, 1928, destroyed a large icehouse on the shore of Coes Pond, Worcester, Mass., damaged extensively two dwelling houses and set ablaze the roofs of more than a dozen other buildings in the vicinity.

The fire originated in the icehouse, supposedly from a cigarette dropped into the hay. Workmen had been employed making repairs on the building, and the first that was known of the fire was when these men, who were at lunch, noticed a sudden flash of flame as the fire burst through the roof. The alarm was promptly given, but the flames spread with such rapidity that when the first companies arrived the entire structure was ablaze. Even while they



Map showing area involved in Worcester, Mass., fire of May 15, 1928.
R indicates fire-resistive roofs. W indicates wood shingle roofs.

P. W. Savage, Worcester Telegram.

Worcester, Mass., icehouse fire. Dwellings damaged by flying embers at right center.

were laying hose lines the burning embers carried to near-by buildings, and in less time than it takes to tell it nine dwelling houses were ablaze.

A third alarm was sounded and apparatus was sent around to Columbus Street and Circuit Avenue to help the householders who were fighting roof fires with garden hose and hand extinguishers as best they could. It was through their efforts that the spread of the conflagration was prevented. As it was, a number of dwellings were damaged to no small extent. Patches of wooden shingles were burned off before watchful men, or in some instances the women and children of the house, could reach the roof with fire fighting materials.

Two dwellings were badly damaged despite the efforts of the firemen and volunteers, entailing losses of more than $8,000. In the score of other structures the flames were confined to small patches of the roofs or to adjoining sheds, and the damage was not great. The total monetary loss from fires caused by flying brands has been estimated to be between $18,000 and $25,000, while the loss on the icehouse is estimated at $200,000 or more.

The accompanying map, on which has been indicated the type of roof coverings on the buildings in the path of flying brands, clearly demonstrates the ability of fire-resistive roofing to retard the spread of fires of this type. In every instance but one, roofs which caught fire were of the wood shingle variety, while those having fire-retardant roofing escaped unscathed. The exception was a dwelling house on Columbus Street, where a fire-retardant roof was ignited. Brands landed in a valley on this roof and were not noticed until they had smouldered for some time. They ignited two of the fire-retardant

P. W. Savage, Worcester Telegram.

Dwelling on Circuit Avenue ignited by brands falling on wood shingle roof.

shingles, which burned and charred to some extent, but the fire did not spread to other shingles in spite of the fact that they were so located as to have the full force of the wind.

Several other dwellings with fire-retardant roofs caught fire, but the roofs were not a factor, for these fires were in portions of the buildings other than the roof. It would appear that the favorable circumstance of the fire occurring in the day time and the large number of buildings with fire-retardant roofs prevented this fire from becoming a general conflagration.

East Concord, N. H.

Wood shingle roofs were a factor in the spread of a fire on May 13, 1928, in East Concord, N. H., which threatened the destruction of the section and completely destroyed the factory of the Samuel Eastman Company, makers of fire department nozzles.

The fire apparently started shortly after noon in an upper room of a double tenement dwelling house from an undetermined cause. When first discovered the fire was wholly within the house, but it broke through the roof soon after the arrival of the firemen in response to an alarm. The water supply was entirely inadequate and a pumper was summoned from the central fire station. Firemen laid a 1,000-foot line of hose from a brook, but were unable to confine the fire to the dwelling, which was by that time completely involved.

The Eastman Company factory, a three-story frame building with a cupola, was situated across a narrow country road from the dwelling house

and was showered with blazing embers from the burning roof carried by a fierce wind from the north. In a very short space of time this building was enveloped in flames. Additional pumping equipment was summoned from the city proper and water was pumped from adjacent brooks and streams.

The railroad station of the Boston & Maine Railroad adjoined the Eastman property. This structure was protected by a tin roof and so escaped, but the freight shed caught fire and was saved only with difficulty. As it was, the wood shingle roof was badly damaged. A freight car, loaded with freshly creosoted ties, standing on a track also was set ablaze, but firemen checked the spread of the flames here.

Sparks and brands were carried half a mile or more by the wind, and buildings far from the scene of the fire were ignited. Four of them were considerably damaged, while a number of other dwellings caught fire but were damaged only very slightly owing to prompt discovery and extinguishment. All of these buildings had wood shingle roofs.

The large country estate of ex-Governor Winant, one of the largest and most up-to-date farms in the state, was in the direct path of the flames and many times sparks and embers landed on the roofs, which did not ignite, being of fire-resistive material. A corner of one of the barns ignited from embers that dropped on the ground near by. Clapboards were ripped away and the incipient conflagration stopped. Had the barn become involved all the farm buildings would have been endangered and adjacent property to the windward of the farm group would probably have been ignited.

The total loss is estimated at from $35,000 to $50,000.

Alexander Industries Fire, Englewood, Colorado.

This report has been prepared from data furnished by the Mountain States Inspection Bureau and the Associated Factory Mutual Insurance Companies (Members N.F.P.A.).

Eleven lives were lost and property damage of $25,000 was occasioned in a fire at the Alexander Industries in Englewood, a suburb of Denver, Colorado, on April 20, 1928. The principal business of Alexander Industries is moving picture film. In a building located about a hundred feet from the rest of the plant they assembled and treated airplane wings, and it was in this building that the fire occurred.

The building was a small unsprinklered one-story structure with an attic and small basement at the rear. The roof was of corrugated iron nailed to wood rafters, and the walls were stucco on metal lath attached to a light wood frame. The windows were factory metal sash with plain glass. Two doors hinged to open inward, located on the east wall, were the only means of exit from the ground floor. One door hinged to open outward located on the south wall was the only means of exit from the basement.

In one corner of the first floor opposite the doors was a sewing room, partitioned off with compo-board and occupied by five or six girls who sewed the fabric on the wing frames. Two doors led from this room into the main room, there being no outside exit, and the metal sash prevented exit through the windows. These girls all perished.

The room outside the sewing room was used largely for lacquer spraying and for painting the fabric-covered wings. There were no booths, and the only ventilation was by a motor-driven fan in the outside wall. The doors were said to be open ordinarily. Beside the spraying, lacquer was applied to wings by a sort of mop from an open fifteen-gallon can. Tape was saturated in other open cans of lacquer.

Lacquer spraying of plane cowls and metal parts was done in the basement. Six air guns with pint containers were used here. There were no booths and the only ventilation was provided by a small motor-driven fan in the side wall.

Housekeeping was reported to have been lax recently because the processes were soon to be moved to a new plant being built in Colorado Springs. Waste material was not removed and the lacquer deposit was permitted to accumulate on the floors and walls. The room was congested with airplane wings being finished. A few chemical extinguishers inside and a hydrant with a limited supply of hose outside were the only protection.

The fire started shortly after eleven o'clock in the morning with the plant in full operation. The basement doors and windows throughout the plant

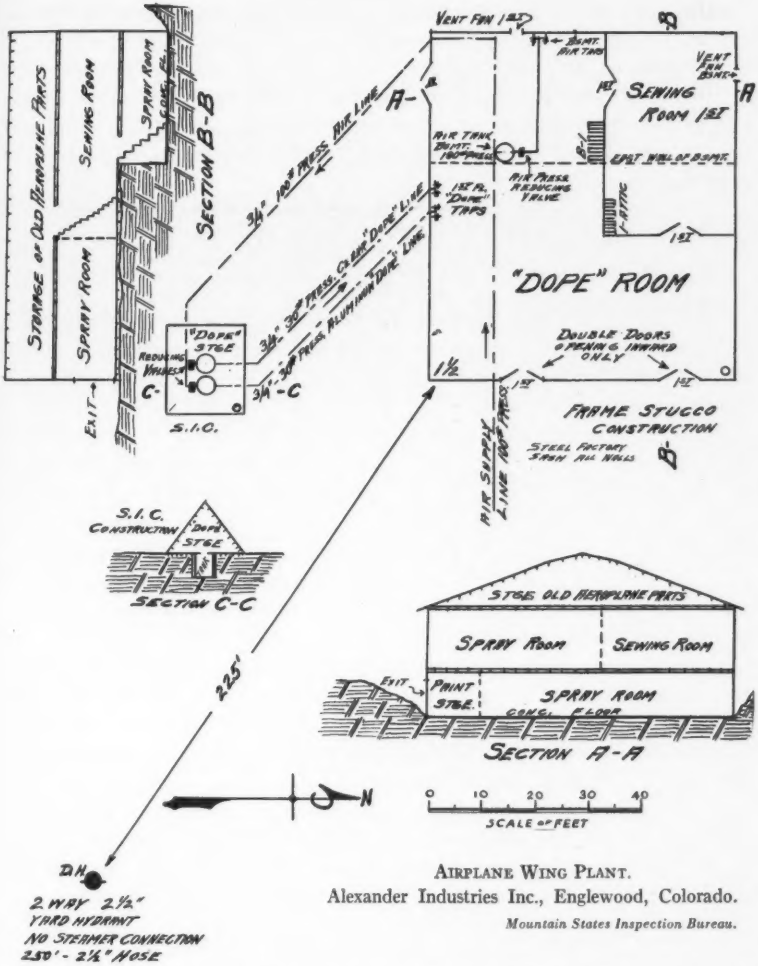
Fire in airplane wing factory of Alexander Industries, Inc., at Englewood, Colorado, where eleven lives were lost, April 20, 1928.

were closed, but the front doors on the ground floor were standing ajar. One of the employees was working in the southwest corner of the spray room sandpapering a wing after the first coat of "dope" had been applied. Another employee was operating a spray gun, and a third had the 15-gallon open can of "dope" in his hand.

An employee was hanging his work up to dry when he saw a spark or small flash at the west end of the building. Another thought he saw a spark from the fan motor located at the west end of the building. A mild explosion, coupled with a dull roar, occurred, followed in quick succession by two more severe explosions which completely enveloped the building in flames, blew the doors closed and piled débris in front of them, so that those who got out escaped with difficulty. While the exact cause of the fire is not known, it is evident that it started in the southwest portion of the first floor where the ventilating fan and motor were located and near where one employee was sandpapering a wing. The first explosion appears to have been due to the ignition of the lacquer vapors, and the explosions which followed were due to the ignition of the deposit and other highly flammable material which was to be found throughout the room.

All of the employees working in the building at the time of the explosion managed to escape with the exception of four women, who were trapped in the sewing room. Their bodies were recovered after the fire was extinguished. Another woman died before she could be placed in an ambulance. All but three of the twenty-six employees in the building at the time of the fire were taken to hospitals, and of these six have died, making a total of eleven deaths.

Workmen in an adjacent building of the plant, hearing the explosions, rushed to the rescue. One employee brought a chemical engine to the scene,



AIRPLANE WING PLANT.
Alexander Industries Inc., Englewood, Colorado.
Mountain States Inspection Bureau.

but found the fire had gained too much headway to use it effectively, so played the stream on the "dope" storage shed adjoining the burning building in order to prevent its catching fire. Others laid a hose line from a yard hydrant two hundred feet away. It was seven minutes before anyone thought to call the fire department.

Three Englewood volunteer firemen had seen the blaze and were just leaving the station as the telephone call came in. On arrival, they attached to a hydrant too far away for their hose line to reach the fire, so they had to

reconnect to a nearer hydrant, which took valuable time. When the firemen arrived they found that the plant employees had not as yet gotten any water on the fire from their yard hydrant. They therefore assisted them and soon had two good streams in operation, but the fire had already gained such headway that destruction of the building was inevitable. Meanwhile a call was sent to the Denver department, which arrived in time to help save the other buildings.

Two hours later the fire in the ruins had been sufficiently extinguished to permit a search for the bodies. The loss to building and contents was estimated to be nearly $25,000.

Conclusions.

Negligence in maintaining cleanliness and providing sufficient ventilation and other safeguards for lacquer-spraying processes in a building of poor construction and inadequate protection appears to have been responsible for the holocaust.

Here is a horrible example of the danger of neglect to safeguard the lacquer hazard. That it can be safeguarded is shown by the favorable record of high-grade industrial plants. Ample ventilation to carry away the vapors, scrupulous cleanliness in removing the lacquer deposits, isolation of the process, good construction, and good protection, are all essential to safety.

The building is not to be rebuilt, and steps were immediately taken to move the process into temporary quarters at another plant of the company pending completion of new buildings there.

The coroner's jury heard testimony following the fire and declared the owners to have been criminally negligent and guilty of "involuntary manslaughter." It is the opinion of the investigators for the State and for the District Attorney that had ordinary, reasonable precautions been exercised in the way of protection, construction and arrangement of the building for safeguarding the spraying hazard, the loss of property would have been greatly curtailed and the loss of life probably avoided, even though a fire had occurred. It also seems clear that had proper exits been provided from the sewing room the loss of life in this section of the building might have been avoided.

Crisfield, Md., Conflagration.

By Underwriters' Association of the Middle Department.
(Member N.F.P.A.)

A fire of conflagration proportions occurred in the town of Crisfield, Md., on Thursday, March 29, 1928, beginning about 8:15 P.M. and completely destroying the main business section before it was brought under control at 3:00 A.M. Friday morning.

The fire, of undetermined origin, started in the Arcade Theatre Building, located at the corner of West Main and South Fourth Streets, near the center of the business district. This building was an old four-story, frame structure, metal clad both inside and out. Although the exact origin of the fire is not known, it is believed to have been caused by sparks lodging under the open foundation, the building being without basement, as a rubbish fire was kindled nearly every afternoon in the rear of the adjoining store property. On the night of the fire the theatre was opened at 7 o'clock and early patrons complained of the heat in the building, although the radiators were cold, the heating system having been shut off for two or three days. No investigation

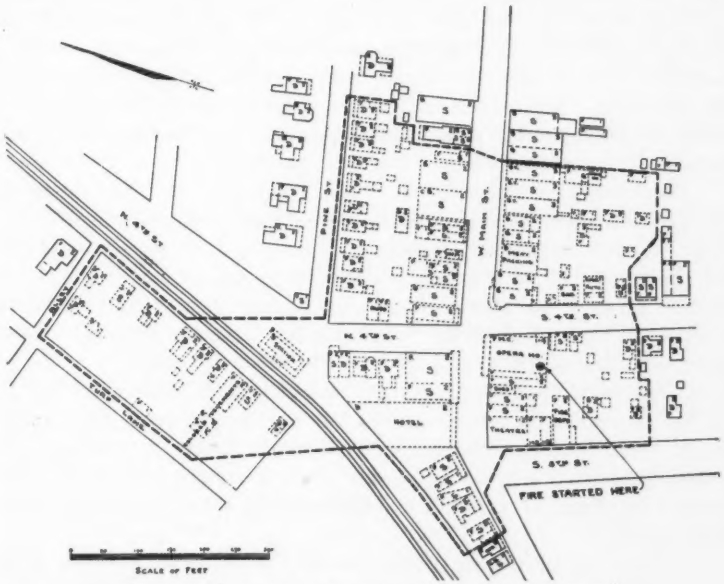
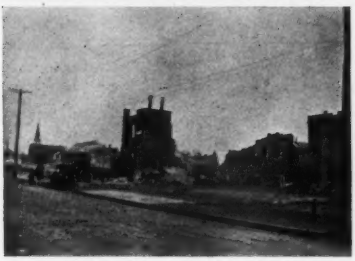


Diagram of burned area, Crisfield, Md., fire of March 29, 1928.



Top: Looking north from West Main Street.
Bottom: Ruins on South Fourth St.

Top: General view on Main Street.
Bottom: Where fire was stopped on East Main Street.

was made at the time, but about 8:15 some of the audience seated under the balcony noticed that metal sheathing on the wall near the floor was becoming quite hot. The theatre was cleared in approximately five minutes without any indication of panic, and within twenty minutes after discovery of the fire the entire building was in flames, indicating that it had been working through the walls for some time.

The Crisfield fire department, located only a block away, responded promptly and proceeded to fight the fire with streams from two pumpers. The flames, however, had already enveloped the building from foundation to roof, and the metal-clad walls greatly hindered the work of the firemen. Two theatres, a garage and several stores, all of frame construction, were located in the small block of which the Arcade Theatre formed a part, and the congested condition caused a rapid spread to the other structures.

A light wind was blowing from the southeast and within a short time the fire had crossed Main Street, only 40 feet wide at this point, and communicated to buildings on both sides of North Fourth Street. A short time later it recrossed Main Street, east of Fourth Street, to a group of brick and brick veneered buildings. These brick buildings did very little to retard the spread of the flames.

At 9:15 P.M. the electric power lines which supplied the pumping station were burned through and the pumps were put out of commission. At the

start of the fire the 150,000-gallon steel storage tank was practically full, but after failure of the pumps it was emptied in about two hours, and it was necessary to take one pumper from the scene of the fire and take suction from the river 800 feet distant, pumping into the water system through a fire hydrant. The other pumper took suction from the distribution system. This pumper was stationed at Pine Street and kept the fire from spreading at this point.

Urgent calls were sent for help, soon after the fire started, to surrounding towns. The Princess Anne Company arrived at 11 o'clock, taking suction from the bay at Chesapeake Avenue, which was possible because of high tide, and took up their position at the northern end of the fire area. Companies from Pocomoke City, Salisbury, and Delmar arrived soon afterward. The pumper from Seaford went out of commission on the way to Crisfield, but the men and hose were sent on by automobile.

The wind died down about 3 A.M. and the fire was brought under control about this time, although it continued to burn until nearly 5 A.M. Friday.

A total of about ninety structures were destroyed, the majority of them being frame business buildings. They included a hotel, two theatres, a garage, railroad station housing the telegraph office, the telephone exchange, a large wholesale grocery house, a meat packing establishment, a number of retail stores and shops, and about thirty residences. One man was killed by a falling wall and quite a number injured.

The damage is estimated at close to $700,000, with probably half of this amount covered by insurance.

Poor construction, congested blocks without fire stops, narrow streets, and pumps dependent on electric power through overhead wires are among the prominent factors contributing to the heavy loss.

Fire Record of Fuel Oil Burners.

The following fire record of fuel oil burners covers fires reported from 1923 to date. These data supplement previous fire records on fuel oil hazards and do not include any fires included in those records.* The previous records have made available comprehensive data regarding the hazards specially requiring to be safeguarded in different classes of property. In this record it has been the intention to carry the analysis somewhat further, indicating the relative frequency of the fires and the loss therefrom, not only by causes but by occupancy as well. To facilitate the analysis, the fires studied have been divided into three groups: heating and power installations in manufacturing and mercantile establishments, process heaters in industrial occupancies, and domestic heating installations.

In the consideration of causes of fires in industrial and mercantile occupancies, regardless of the type of installation, careless or improper operation heads the list. It appears that employees engaged in operating fuel oil systems often do not receive proper instruction as to the consequences likely to ensue not only to the plant but to themselves if they fail to exercise due caution at all times. It would further seem that men employed in making repairs on fuel oil systems use but little care and have but little knowledge of the importance of shutting off the fuel oil supply while they work on the system. Attempts on the part of incompetent or inexperienced employees to remedy leaks, etc., have caused a number of serious fires.

The considerable number of fires from failure of oil piping and fittings seems to indicate lack of proper inspection. Were installations thoroughly and frequently inspected for defects and leaks, many fires from leaky joints and fittings would be prevented. In the case of process heaters, fires caused by failures in the oil line are apt to be serious, due to the fact that with most such installations oil is delivered to the burner under considerable pressure and a very quick hot flame is developed when a pipe or joint fails and the oil under pressure is ignited. The danger to unprotected pipes from mechanical injury is a problem of considerable importance in the case of process heaters.

A comparison of the causes of fuel oil fires in industrial and mercantile occupancies, as given in the present record with similar tabulations published in previous issues of the *Quarterly*, shows that despite the many developments in the oil burning field, careless operation is still responsible for the largest number of fires, the percentage of fires due to this cause being substantially the same in the original fire record published in 1913 as in the present record. The 1913 tables indicate that 24.6% were due to careless operation, and the 1928 tables show 25.2% due to the same cause. The principal change from

*Refer to *Quarterly*, Vol. 7, No. 1, page 71, and *Quarterly*, Vol. 12, No. 1, page 90.

the original record lies in the percentage of fires due to failure of oil piping or fittings, this having been 42.5% in 1913 and 15.3% in the present record.

The following tables show the causes of fires and losses, by occupancies, classified in various ways. No tables of methods of extinguishment are included, as insufficient data on this appeared in the majority of the original reports. Although there was insufficient data to compile any statistics of efficiency, it is of interest to note that automatic sprinklers appeared generally effective on fuel oil fires in heat and power installations.

Heat and Power Installations.

Occupancies Involved.

Manufacturing	37
Mercantile	36
Garages	18
Other Occupancies	16
Total	107

Losses by Occupancies.

	Manufacturing	Mercantile	Garage	Other	Total	%
From 0 to $499	31	28	17	10	86	80.5
From $500 to $999	2	3	0	0	5	4.7
From $1,000 to $2,499	3	0	0	2	5	4.7
From $2,500 to $4,999	0	0	1	0	1	.8
More than $5,000	1	5	0	4	10	9.3
	37	36	18	16	107	100%

The larger losses in mercantile and other occupancies are probably due to the fact that in most instances separate boiler rooms are not found, as in manufacturing occupancies, and that the contents of mercantile establishments are more susceptible to heavy smoke damage.

Extent of Fire by Occupancies.

	Mfg.	Mercantile	Garage	Other	Total	%
Confined to Burner and Boiler Pit	8	8	6	2	24	22.4
Confined to Boiler Room	25	23	12	10	70	65.6
Spread to Other Parts of Building	4	4	0	4	12	11.2
Smoke Damage in Building	0	1	0	0	1	.8
	37	36	18	16	107	100%

Causes of Fire by Occupancies.

	Mfg.	Mercantile	Garage	Other	Total	%
Careless Operation	9	9	3	2	23	21.4
Failure of Oil Piping or Fittings	5	6	0	0	11	10.3
Defective Burner	0	1	5	3	9	8.4
Carbonization of Burner	3	5	1	0	9	8.4
Failure of Ignition Devices	4	2	2	1	9	8.4
Failure of Automatic Shut-off Valve	4	1	1	2	8	7.5
Oil Storage Systems	1	1	0	3	5	4.7
Faulty Installation	3	2	0	0	5	4.7
Faulty Operation of Pump or Feed Mechanism	3	0	1	0	4	3.7
Failure of Manual Shut-off Valve	1	1	0	0	2	1.9
Faulty Carburetion	1	1	0	0	2	1.9
Poor Housekeeping	0	0	0	1	1	0.7
Back Fire—No definite cause	2	2	5	1	10	9.6
Not Stated or Determined	1	5	0	3	9	8.4
Total	37	36	18	16	107	100%

Extent of Fire and Losses by Causes.

Cause	Extent of Fire			Losses					
	Burner and Pit	Ext'd to Boiler Room	Ext'd to Bldg.	From 0 to $499	$500 to $999	$1,000 to $2,499	$2,500 to $4,999	Over $5,000	Total Fires
Careless Operation.....	8	13	2	17	3	2	0	1	23
Failure of Oil Piping or Fittings	1	8	2	8	1	0	0	2	11
Defective Burner.....	4	4	1	7	0	1	0	1	9
Carbonization of Burner....	3	6	0	9	0	0	0	0	9
Failure of Ignition Devices.	2	5	2	7	0	0	1	1	9
Automatic Shut-off Valve Failure	1	6	1	7	0	0	0	1	8
Oil Storage System.....	0	3	2	2	0	1	0	2	5
Faulty Installation.....	1	4	0	5	0	0	0	0	5
Faulty Operation of Pump or Feed Mechanism.....	0	4	0	4	0	0	0	0	4
Manual Shut-off Valve Failure	1	1	0	2	0	0	0	0	2
Faulty Carburetion.....	0	2	0	2	0	0	0	0	2
Poor Housekeeping.....	0	1	0	1	0	0	0	0	1
Back Fire—No specific cause	3	7	0	10	0	0	0	0	10
Not Stated or Determined..	0	6	3	5	1	1	0	2	9
Total.....	24	70	13	86	5	5	1	10	107

Typical Fires.

Careless Operation.

WALTHAM, MASS., SEPT. 11, 1926. BLEACHERY. While a watchman and fireman were in the boiler house a violent explosion occurred, blowing off the rear baffle plate and explosion door of one of the boilers. Heavy wood paneled doors were also blown off their hinges. The fireman was injured and burned, while the watchman escaped.

Oil burners were of a type using steam as an atomizing agent. Several days prior to the explosion the fuel oil tanks were cleaned. In order to conserve as much of the oil as possible the residue was returned to the tanks through a strainer, which resulted in an oil apparently with considerable impurities and thicker than that ordinarily used. This oil was being burned at the time of the explosion. On account of the lesser amount of steam being required at the mill the various adjustments on the burner were limited accordingly, including damper control, which had the effect, because of the impure oil, of causing a retarded action in the burner. It is believed that this permitted unburned gases to accumulate until an intermittent sudden burst of flame ignited the gases and caused the explosion.

It is intimated that the fireman in charge at the time had a limited experience with oil burning equipment, and that the abnormal functioning of the burner prior to the explosion was sufficient warning for immediate investigation, which, if conducted, would have permitted necessary readjustments of burner, and thus prevented the accident. (S-43585.)

IRVINGTON, N. J., DEC. 11, 1926. METAL WORKER. Watchman started the oil burners, using an air pump for pumping the oil. When 60 lbs. steam pressure was reached he shut down to change over to steam pumps and evidently left the valve at the burner partly open, permitting oil to escape

on to the floor. When he opened the valve and applied his torch a back fire occurred, igniting oil on the floor. Chemical lines were used to extinguish the fire. Loss was about $1,000. (S-43907.)

WATERTOWN, MASS., FEB. 18, 1927. DYEING AND CLEANSING PLANT. A flare-back occurred at an oil burner and was caused apparently by the damper not being open when the fireman attempted to start up an additional boiler. No property damage, but fireman died a few days afterwards as a result of burns received when his clothing caught fire. (S-44076.)

RED BANK, N. J., MARCH 8, 1927. THEATRE AND STORES. Fire was said to have been caused by explosion or puff from pit of boilers, fuel oil fired. Burner with mechanical draft was employed, manually lighted. Large heating boiler was supplied by two burners, and operator is said to have lighted burners by using an ordinary paper towel as a torch. Apparently thinking that both burners were lighted, he left the boiler room. In a few minutes he returned and discovered that only one was lighted, and it is thought that in attempting to shut off burner which was not lighted he opened it instead. Oil flowed into the pit of the boiler, and an explosion occurred. The front doors of boiler were blown off and ruptured overhead fuel oil supply line to burners. Pressure relief valve in suction line from tank to pumps operated and stopped pumps. The amount of actual fire was small, involving only discharged fuel oil and part of wooden switchboard. Operator was badly burned about face and arms. Fire department used chemicals to extinguish the fire. Loss slight. (S-44905.)

BOSTON, MASS., SEPT. 2, 1927. FURNITURE FACTORY. Fire was caused by the overflow of fuel oil supply tank while being filled from tank wagon. It appears that one of the two fuel oil burners had been removed for repairs and the return pipe had not been capped when the burner was disconnected. When the supply tank overflowed the fuel oil ran out of the uncapped end of the return pipe on to boiler room floor. Due to a downward pitch in the floor the oil flowed into ash pit of boiler and was ignited by a rubbish fire that was burning inside. Fire sprinklers opened and a chemical stream was used to extinguish the fire. Loss was small. (S-45600.)

WOONSOCKET, R. I., NOV. 17, 1926. YARN MILL. An explosion in fuel oil fired boiler resulted in doors on front of boiler being blown open, monitor in boiler room blown out, fire doors to adjoining buildings blown open, and fire following explosion communicating to adjoining room. The exact cause of the explosion is not known, but a reasonable explanation lies in the possibility of controlling oil valve not being tightly closed during shut down of burners. In this event the extremely limited amount of air under this boiler would result in vaporization and imperfect combustion of oil. When air supply ducts were opened an explosion naturally took place. The loss was $724.00. (S-43819.)

KANSAS CITY, MO., SPRING, 1924. MERCANTILE. Fire in the heating boiler had been out for a short time and when again starting the fire the engineer turned on the oil, which was fed to the furnace by pump, but did not provide any blaze in the boiler to ignite the oil. It is not known why this was not done, but engineer apparently thought that there was still enough heat in the boiler to ignite the oil. As the fire failed to start, he shut off the pump, dipped some oily waste into some heavy oil used for starting fires, placed it on the end of a metal rod, ignited the waste and put it into the fire box. As he

did so, an explosion occurred, burning the engineer badly. No fire damage resulted to the building or its contents. It appears that in this case there was sufficient heat in the boiler to cause a rapid generation of gas from the oils which were pumped into the fire box, but not enough heat to ignite the oil. A pocket of gas was thus formed in the boiler, which exploded upon insertion of the torch. (H-21125.)

Failure of Oil Piping or Fittings.

BOSTON, MASS., APRIL 7, 1926. METAL WORKER. Fire was caused by a leak in oil line in front of the boiler. Leak had existed for quite a long time and oil had soaked into rubbish in front of boiler, probably vaporizing and causing ignition from fire under boiler. All of the fire was on the floor outside of the boiler. Two sprinklers operated and extinguished the fire. Loss slight. (S-41881.)

SOUTH RIVER, N. J., APRIL 26, 1926. COTTON EMBROIDERY FACTORY. This fire was caused by a break in the piping at the fuel oil burner on the heating boiler. The oil flowed to the basement from two buried tanks outside. At the burner there were three pieces of flexible metallic pipe used at the oil pump. They were secured by soldering into the threaded couplings at either end. The solder probably was the weak point. The flexible hose in front of the fire box developed a leak, spraying the hot boiler setting with fuel oil. One sprinkler opened, extinguishing fire. Loss was slight. (S-42620.)

WASHINGTON, D. C., APRIL 2, 1928. PRINTER AND BINDER. Fire started at the oil burner in the basement. It is thought that a coupling or union at the pressure gage on burner became loose and allowed the oil to flow out on the cement floor and run back under the boiler. The oil burner had a thermostatic control which automatically functioned at a certain temperature. When the temperature in the building became low enough to operate and start the heater, the flame flashed back and ignited oil which had leaked out on to floor and in fire box. One sprinkler operated and extinguished fire. Loss $300.00. (S-47223.)

BUFFALO, N. Y., MARCH 19, 1924. DEPARTMENT STORE. Fire was caused primarily by leaky oil piping of a fuel oil fired boiler in basement. Oil withdrawn from supply tank by a motor driven pump was pumped to oil burner equipment through a small tank or chamber which served to equalize the oil pressure and neutralize the pump pulsations. This chamber rested on floor at the same level as the burner. A pipe from top of this chamber served to return all excess oil pumped to supply tank and also provided a head or pressure. Oil leaked at the rate of several drops per minute from the lower (and probably also the upper cap) of this oil chamber, as oil appears to have destroyed the cement used in making up the screw joints. Oil ran down into the sump in concrete floor which accommodated boiler, and probably against or even through base into fire box. Oil ignited and flared up back of boiler, burning off some of the pipe covering and slightly charred ceiling boards and joists. Two sprinklers operated and practically extinguished fire. No claim for loss. (S-37262.)

Defective Burner.

BRANFORD, CONN., MAY 4, 1926. SHIRT MANUFACTURING, WITH STORES ON STREET FLOOR. The fire occurred in a non-cut-off boiler room located in the center of the building. The heater was equipped with an approved fuel oil burner equipped with a thermostatic control.

A boy was employed to start the burner in the morning before the shop opened. This boy had started the burner in the usual way and had returned to the floor above, where he worked. Fifteen minutes later smoke was observed coming through the second floor, and upon examination the entire boiler room was found to be in flames. By the time the town fire department had arrived the fire had followed up the walls to the concealed space under roof, where the most damage was done by flames.

The fuel oil burner and equipment were carefully examined. In this type of burner was an anti-flooding device or trip pan designed to shut off oil in event of oil overflowing in combustion chamber. This trip pan was found in a normal position, *i.e.* not tripped. This device was tested by pouring a pail of water in the combustion chamber and the device functioned. In addition to the control switch there was a pull socket switch on ceiling connected to shut off burner motor. This was operated by a weight which dropped when either one of two fusible links, one located at ceiling and the other at draft of ash pit door near floor and near burner apparatus. The fusible link near floor had not been operated or separated, but link near ceiling was found fused. The pull socket switch was in a closed position, indicating that the apparatus had not functioned as intended.

It appears that this burner had failed to operate properly on several occasions and only a few days previously the representatives of the oil burner dealer had been called upon to fix it. Large loss. (H-23294.)

BOSTON, MASS., FEB. 27, 1927. GARAGE. Fire occurred at oil burner, being more in the nature of smoke disturbance rather than fire. Unburnt oil flowed out of small opening at bottom of brick front and burned outside the boiler.

The burner was of spinning cup type, which depends upon the passage of air at low pressure through a small gear type turbine to rotate the cup and thus break up the oil into small particles and to distribute it uniformly inside the fire box. As well as can be ascertained, the nut securing one of the ball bearings carrying the spinning cup became loose and allowed the spinning cup to drag on the fixed casing surrounding it. This stopped the spinning action and caused oil to flow into the fire box without being sufficiently atomized to burn properly. Damage was confined to smoke on walls and ceiling of boiler room and to paint on boiler. Fire was extinguished by two sprinklers. (S-44274.)

Carbonization of Burner.

BOSTON, MASS., FEB. 13, 1927. SHOE FACTORY. The boiler used for heating this plant was fired by two oil burner units, burning heavy fuel oil. During the absence of the janitor, a slowly rotating burner caused a cone of carbon to form. Oil accumulated, stopping the burner rotation and then discharging on the floor. A small fire ensued near the motor driving the boiler feed water pump. A resulting short circuit at this point blew the fuses, stopping the oil and air pump motor, which was on the same line. Sand and water were used to extinguish the fire. Loss slight. (S-44260.)

Failure of Ignition Devices.

BUFFALO, N. Y., DEC. 22, 1924. ELECTRIC LIGHT FIXTURES. Fire occurred in and near a low pressure boiler in basement equipped with fuel oil burners. Apparently, on account of the occasional weakening or failure of the

four dry battery cells used to ignite the intermittent pilot light located at the tip of each of the burners in connection with the temperature control thermostat, the boiler man installed two constant burning gas pilot lights for igniting the fuel oil in case of battery failure.

Exact cause of fire is not known, but is thought to have been due to the constant burning pilot light having been blown out or otherwise extinguished, and that the spark ignition for the intermittent pilot light later on ignited the accumulated gas and/or oil in the fire box when lowering room temperature brought the thermostat into operation. Fire box doors were blown open so forcibly that one was broken in two. Flames and some oil came out into the basement, and oil is said to have burned on the floor. Ceiling joists were slightly charred over a small area. One sprinkler operated and prevented these joists from burning. Damage appears to have been mainly the wetting of the boiler insulation lagging, to the motors for burners, and possibly a little smoke damage. (S-39179.)

NEW HAVEN, CONN., NOV. 21, 1926. GARAGE. This oil burner had been in operation about one month. It is reported that the installing concern had advised the owner that crank case oil could be used satisfactorily. At the time of the explosion the supply tank is said to have contained largely furnace oil with some crank case oil.

It appears that this device was being operated at short intermittent periods of firing from a boiler control, the burner being stopped and started as a result of the building up or decrease of steam pressure. When operated in this manner the burner might be subject to a number of intermittent starting and stopping operations every hour, with the result that the fuel each time was introduced into a hot combustion chamber. Of course this is relatively dangerous if the pilot is not in good operating condition, and it cannot be said that explosions would not have occurred if the flash point of the fuel was above the normal or average flash point of fuels for which this burner was designed. It is quite possible, however, that the use of crank case oil aggravated the situation in that the propagation of flame through the oil and air mixture is faster in the case of the more volatile fuels than with the general run of fuel oil.

The gas pilot was also very much at fault. It seems likely that corrosion, scale or dirt had produced a temporary stoppage of the aperture through which gas is normally supplied to the small pilot flame. This is a factor of inherent danger in devices of this kind, and the extinguishment of the pilot flame in other cases has produced trouble.

Two sprinklers in front of the boiler opened, but there was no evidence of burning except a few papers tacked to the wall near boiler were burned. The explosions blew off the front doors of the sectional heating boiler and also the large uptake flue in the back. The first floor of the building was lifted perceptibly, and the fancy concrete overlay of the show room floor was badly cracked. All of the windows were blown outward. (S-43486.)

BOSTON, MASS., NOV. 10, 1927. GARAGE. Back fire from an oil burner was probably due to the gas pilot not expanding sufficiently to ignite the oil when the burner came on. This allowed the atomized oil to enter hot fire box

and when sufficient gas had been generated it ignited and caused a back fire. The burner was under thermostatic control. Two sprinklers operated and practically extinguished the fire. Loss was moderate. (S-46202.)

Failure of Shut-off Valve.

ATLANTA, GA., APRIL 23, 1928. AUTOMOBILE ASSEMBLY. Fire was caused by back draft of flame from fuel oil burner igniting oil, which was overflowing from individual reservoirs supplying oil to each burner in one of the heating units used for heating the building. The overflowing was said to be caused by the failure of both the automatic control valve and the safety shut-off valves.

On account of no damper regulation of the heat discharging from the heater, an excess of heat was generated which caused a back draft from one or more burners. On account of this excess heat the automatic air control operated, shutting off the oil supply to the individual burner jets, which allowed the individual reservoirs under each burner jet to overflow, and as the automatic float valve in the oil storage unit did not operate it became filled with oil. This should have operated the safety shut-off valve had it been properly adjusted.

Seven sprinkler heads operated, and held the fire, aided by six foam type extinguishers. Loss was small. (S-47444.)

EVERETT, MASS., MARCH 10, 1927. MACHINE SHOP. A fuel oil fire due to failure of automatic control devices to function occurred in the boiler room, causing a moderate loss. The burner was equipped with a regulator actuated by a thermostatic device in the boiler stack arranged to control the size of the gas pilot flame. The regulator also functioned to prevent the abnormal discharge of oil in case of lack of ignition from the pilot by opening the switch controlling the oil pump burner, thereby stopping the flow of oil. This latter control was supposed to operate within 40 or 50 seconds after failure of ignition from the pilot.

It is evident that a failure of oil to ignite from the pilot occurred and that the automatic oil shut-off failed to function. Oil flowed into the fire pot and out on to the floor of the boiler pit, where it ignited. Five sprinklers opened and extinguished the fire. (S-44278.)

Oil Storage System.

CAMBRIDGE, MASS., DEC. 24, 1926. WAREHOUSE. Fire was caused by leakage from the fuel oil tank. The tank was located in former coal bin and was cut off by a brick wall. Space between wall and tank was filled with sand.

Shortly before fire occurred, approximately 750 gallons of fuel oil had been pumped into the tank. During filling operation it is said that a cracking sound was heard. Somewhat later an employee entered boiler room and discovered several inches of oil on the floor.

The oil had flowed into the ash pit and was burning. Chemical streams proved ineffective and an attempt was made to bail out the oil. The motion set up in the oil caused the fire to flash out into the boiler room and the men fled, leaving the door open. Flames shot out into the first floor, but were beaten back with chemical streams, and the door was closed by use of a hooked pole.

Prior to the last few fillings tank had been filled by gravity, and it seems reasonable to believe that pumping into the tank (pressure being built up by the power pump on the tank wagon) caused it to rupture, possibly because of plugged vent pipe. Fuel oil burning equipment was not a factor in causing the fire. Oil burner, switches and hot water heating equipment were damaged. Loss was about $1,000. (S-43723.)

UTICA, N. Y., APRIL 14, 1927. TENANT BUILDING. The oil company delivered a supply of fuel oil. Owners state that too much oil was delivered, so that tank overflowed and employee stated that oil flowed from loose plug in small tank. Latter statement seems most probable. Fire occurred while men were cleaning up this oil. Oil burners were in operation at time, and either oil ran into pit where burners were located or oil was splashed on hot burners. One sprinkler operated and extinguishers were used to put out fire. Loss was small. (S-45192.)

SPRINGFIELD, MASS., FEB. 5, 1925. MISCELLANEOUS MANUFACTURING. The boiler supplying heat for this building was heated by fuel oil. Oil was stored in an underground tank. There were two five-gallon tanks, one used as a vacuum tank and the other containing two gallons of fuel oil. Oil was pumped from outside tank, one gallon at a time, to the inside service tanks by vacuum and automatically. One of these tanks leaked at the end and had been soldered before, but still leaked slowly. The surplus oil evidently flowed over the floor and apparently in a small quantity, until near the burner, where possibly gases were ignited and caused a flash fire which opened four sprinklers. There was no loss, fire being confined to burning of the oil. (S-39043.)

Faulty or Improper Installation.

MONTREAL, QUEBEC, JAN. 21, 1925. SHOE FACTORY. Watchman discovered smoke and found that ash box of heater in basement had become flooded with fuel oil, which was burning and throwing off volumes of smoke. He attempted to smother burning oil with sand, and while throwing in a second pailful a back draught or puff from partly smothered oil occurred and flames burst from ash box, enveloping the watchman and throwing him about ten feet from the furnace. Although quite badly burned about the head and with his shirt smouldering, he hastened to fire alarm box in entrance of building, opened door, but failed to pull hook, as this alarm was not sounded. He then sounded alarm over night watch system to central station.

When fire department arrived oil was still burning, although watchman had shut off oil supply. Fire eventually went out, there not being enough air to support combustion when burner ceased to revolve.

Trouble was due to carbonizing of burner occasioned by too small an opening in fire box around the burner. This "flare up" is the second to occur at this plant, the other being in the heater for the tank house and happened about a year ago. The trouble was from the same cause, namely, carbonizing of the burner due to too small an opening around it, and when this space had been enlarged no further trouble was experienced. Small damage. (S-38994.)

SALEM, MASS., DEC. 3, 1927. WOODWORKER. A small fire, originating apparently from improperly wired oil burner, occurred at this plant. It is said that this wire was fastened to piping in the pit by tape and that it could

not have broken from swaying or rubbing. From the fact that the wiring was fused, however, it would appear that in some manner this wire was broken and made light contact either with the motor to which it should be connected or to a grounded pipe or part of the burner, and when the motor started up automatically a spark resulted which ignited the insulation or possibly a small amount of oil on the floor of the pit, or both. Three sprinklers operated, completely extinguishing the fire. The amount of oil involved in the fire was small and burned up before water reached it from the sprinklers. Loss was small. (S-46340.)

BUFFALO, N. Y., FEB. 4, 1927. METAL WORKER. Fire originated in fuel oil around base of oil-fired low pressure boiler. It was caused apparently from the ignition of oil running into ash pit by reason of the lever valve oil throttle of oil burner having been carelessly brushed open by a workman. It is supposed that watchman started oil pump and air blower in adjoining room, that oil escaped from the opened burner valve, and that ignition took place when he attempted to light burner with a piece of oily waste on end of a bar. Three sprinklers opened and a foam extinguisher was used to extinguish the fire. Loss slight. Recurrence of fire from this cause is improbable, as a lock has been placed on lever oil burner valve. (S-44635.)

Pump or Feed Mechanism.

BOSTON, MASS., MARCH 19, 1922. GARAGE. Fire occurred in boiler room, due to air pressure in the fuel oil system becoming low, which allowed the oil to run out upon the floor. The oil ignited and caused a small fire. One sprinkler operated and extinguished the fire. No claim for loss. (S-31692.)

Faulty Carburetion.

BOSTON, MASS., DEC. 20, 1926. WHOLESALE SHOE DEALER. Fire started in boiler room and was due to a small amount of heavy fuel oil igniting on the boiler room floor. Improper combustion of fuel oil of poor quality caused the unburned oil to drop into base of fire box and through small openings to concrete floor in front of boiler. This oil was ignited from the hot carbon which had formed on the fire box walls. One sprinkler and automatic shut-off from oil tank operated and extinguished fire. Emergency oil switch at door was also pulled. Slight loss. (S-43771.)

PROVIDENCE, R. I., FEB. 9, 1926. JEWELRY FACTORY. Fuel oil burner was giving some trouble by not properly vaporizing oil, some of which ran out under boiler on to floor under fire door. Here it slowly vaporized, drifted into fire box and ignited, causing a flare on the floor. Two sprinklers operated and entirely extinguished fire. There was no claim for loss. (S-41692.)

Poor Housekeeping.

PROVIDENCE, R. I., JAN. 16, 1928. HOTEL. Fire occurred in dirt and oil smoke deposit in concealed space over boilers formed by metal sheathing nailed to under side of joist ceiling over boilers. Four sprinklers operated and the fire department used a chemical stream to extinguish the fire. There was considerable smoke, but there was no smoke damage claimed. Fire damage was to metal sheathing over boilers, and water damage to asbestos covering over steam pipes and boiler flue, etc. (S-46648.)

Process Heaters

Processes Involved.

HEAT TREATING	19	METAL FINISHING AND ASSEMBLING.	12
Annealing	7	Carbonizing	2
Tempering	4	Pickling	1
Hardening	2	Tinning and Galvanizing.	3
Not Specified	6	Blueing	1
FOUNDRY AND FORGE SHOP PROCESSES	33	Rivet Heating	5
Casting or Forging	8	MISCELLANEOUS	12
Melting	5	Pottery Kiln	2
Bending	3	Roofing Works	2
Core Making	5	Insulating Compound	2
Not Specified	12	Rosin Kettle	1
SPRAYING AND FINISHING	7	Not known	5
Dryers	7		
		TOTAL FIRES	83

Losses by Processes.

	Heat Treating	Foundry and Forging	Metal Finish'g	Spraying and Finish'g	Misc.	Total	%
From 0 to $499	7	14	8	2	7	38	45.8
From $500 to $999	2	7	2	1	1	13	15.6
From $1,000 to $2,499	6	6	0	2	0	14	16.9
From $2,500 to $4,999	2	2	0	1	0	5	6.1
Over $5,000	2	4	2	1	4	13	15.6
Large—Loss not stated	0	0	0	0	0	0	0
Total	19	33	12	7	12	83	100%

Causes by Processes.

	Heat Treating	Foundry and Forging	Metal Finish'g	Spraying and Finish'g	Misc.	Total	%
Careless Operation	3	12	4	1	3	25	30.2
Failure of Oil Piping and Fittings	4	7	2	1	4	18	21.7
Pipes, Valves or Fittings Broken by Accident	7	3	1	1	1	13	15.6
Failure of Shut-off Valve	1	5	1	0	1	8	9.6
Storage of Oil	0	1	2	0	1	4	4.8
Faulty Carburetion	1	1	0	1	0	3	3.7
Carbonization of Burner	1	0	0	0	1	2	2.4
Defective Burner	0	1	0	0	0	1	1.2
Faulty Installation	0	1	0	0	0	1	1.2
Faulty Operation of Pump or Feed	0	0	0	1	0	1	1.2
Poor Housekeeping	1	0	0	0	0	1	1.2
Back Fire	0	1	0	1	0	1	1.2
Not Stated or Not Determined	1	1	2	0	1	5	6.0
Totals	19	33	12	7	12	83	100%

Extent of Fire by Processes.

	Heat Treating	Foundry and Forging	Metal Finish'g	Spraying and Finish'g	Misc.	Total	%
Confined to Burner or Appliance	3	5	4	1	5	18	21.5
Confined to Room of Origin	14	22	6	5	3	50	60.5
Spread to other parts of Building	2	6	2	1	4	15	18.0
Total	19	33	12	7	12	83	100%

Extent of Fire and Losses by Causes.

	Extent of Fire			Loss					
	Confined to Appliance	Spread to Room	Spread to Bldg.	0 to $499	$500 to $999	$1,000 to $2,499	$2,500 to $4,999	Over $5,000	Total
Careless Operation	6	18	1	14	5	2	3	1	25
Failure of Oil Piping and Fittings	3	8	7	6	2	3	1	6	18
Feed Pipe, Valves or Fittings Broken by Accident	2	9	2	4	2	5	0	2	13
Failure of Shut-off Valve	1	6	1	3	2	1	1	1	8
Storage of Oil	2	0	2	2	1	0	0	1	4
Faulty Carburetion	0	3	0	0	0	3	0	0	3
Carbonization of Burner	2	0	0	2	0	0	0	0	2
Defective Burner	0	0	1	0	0	0	0	1	1
Faulty Installation	0	1	0	1	0	0	0	0	1
Faulty Operation of Pump or Feed	0	1	0	0	1	0	0	0	1
Poor Housekeeping	0	1	0	1	0	0	0	0	1
Back Fire	0	0	1	0	0	0	0	1	1
Not Stated or Determined	2	3	0	5	0	0	0	0	5
Totals	18	50	15	38	13	14	5	13	83

Typical Fires.

Careless Operation.

ERIE, PA., DEC. 16, 1924. STEEL FOUNDRY. Man was tapping oil burner to dislodge dirt in it when ¼-inch supply pipe to it broke. Oil ignited from heat of oven and flames shot out, warping the steel floor above and bending the steel I-beams supporting it. Oil was shut off at tank and pump. One hose stream was used to extinguish the fire. Loss was estimated at $1,500. (H-22143.)

NORWOOD, MASS., MARCH 5, 1924. ROOFING WORKS. This plant has two oil circulating systems with superheaters for heating asphalt tanks. These two systems are tied together with valves on feed and return lines dividing each system. Type of oil used has a flash point of around 600° F., and the oil in the system is heated by outside fuel oil-fired superheaters to around this same temperature.

A leak of minor nature had caused the shut-down of one of these systems for probably 24 hours, permitting pipe, etc., to cool, the high temperature remaining in the other. Following the repairs oil was pumped into a part of

system and gates opened slowly between the two. The hot oil from the system in use passing into the cold system caused heavy strain, due to expansion and change of temperature in parts, causing a rupture in the casing of one of the control valves separating systems.

The oil, heated to its ignition temperature and probably cracked, due to continuous high temperature, thus lowering flash point, upon coming into contact with the oxygen in the air burst into flames. Damage amounting to $18,000.00 was done by the resulting fire. (S-36846.)

CHICAGO, ILL., FEB. 3, 1925. METAL WORKER. The furnace tender attempted to tighten a union on the fuel oil line, which broke at the burner. The oil flowed out and ignited, severely burning the man and setting fire to the building. Apparently the oil from the tank was nearly exhausted before the valve controlling the supply to the burners could be reached and closed, owing to the nearness of the fire. The sprinklers were shut off for the winter and the flames made rapid headway before the sprinkler valve could be opened. Seven sprinklers operated, and two large hose streams were used to extinguish the fire. Loss was about $2,500. (S-39404.)

BUFFALO, N. Y., JAN. 10, 1925. AUTOMOBILE ACCESSORY FACTORY. The die casting furnaces in the foundry were heated by an interlocking fuel oil system. The oil gravitated to burners from an overhead line. After heating each casting an employee gave it a sharp knock to loosen it. This continual knocking in time fractured the pipe near one burner, and the flowing oil, being so near the burner, was ignited. Burning oil was extinguished by foam extinguishers. Loss was very small. (H-22233.)

CLEVELAND, OHIO, APRIL 6, 1926. METAL WORKER. Fire was probably caused by carelessness in lighting the fuel oil burners under the galvanizing furnace. It is thought that the oil valve was opened without opening the air valve, and the employee went to get some waste to light and throw into the furnace to start the fire, failing to return as promptly as he expected, which allowed unburned oil to accumulate in the pit under the furnace. When the employee finally turned on the air and lighted the burner the whole under part of the furnace burst into flames. The exposed fuel oil supply pipe passing around the pit of the furnace was heated to a very high degree by the flames. When the fire started an employee tried to put it out with a small garden hose, and the water striking a cast iron elbow in the fuel oil supply pipe caused it to crack and the pressure of the oil blew it out entirely, allowing a one-inch stream of fuel oil to flow into the fire. The valves in the main fuel oil supply line were shut as soon as possible, but not before a large quantity of oil had collected. Chemical extinguishers and a hose stream were used to extinguish the fire. Loss was between $300 and $500. (S-42043.)

NEW BRITAIN, CONN., SEPT. 2, 1925. HARDWARE MANUFACTURING. An attendant at a tempering oven, noting that one of the fuel oil burners was clogged, shut off the oil supply and cleaned the burner tip. Apparently unatomized oil from the partly clogged burner had collected in the bottom of the oven, for when the burner was relighted a flash of fire occurred, which partly enveloped the attendant and burned his coat sleeve. He ran back to the control valve and shut off the oil supply. A hot fire continued in the oil on the floor surrounding the furnace and in the dry and oily woodwork in the vicinity. This opened eighteen sprinklers, which controlled the fire. Loss was about $3,000. (S-40633.)

HAGERSTOWN, MD., JUNE, 1926. FOUNDRY. Fire was caused by explosion in combustion chamber of fuel oil furnace used for melting metal for casting. Furnace is gravity fed from 50-gallon tank outside. Employee operating furnace shut off valves before leaving. Superintendent made inspection preparatory to leaving for the night and tried valve, opening same. The furnace was new and superintendent did not know which way valves turned. Shortly after he left furnaces exploded. One sprinkler operated and extinguished fire. Loss was small. (S-43546.)

MONTREAL, P. Q., AUG. 28, 1923. CAR WORKS. Fire resulted from faulty operation of a fuel oil furnace by an employee. Furnace had been operating during the day. After plant had shut down an employee put furnace in operation again to do some special bending of iron rods. It is surmised that oil control valve was opened first instead of air valve, and resulting flow of oil ignited from hot furnace. Jet of oil shot into the air and burning oil set fire to wood framing of wall near by. Heat fused two sprinklers in roof 40 feet above, but water could not reach blaze, which had worked between a baffle plate and wall of building. One private hose stream and extinguishers put out the fire. Loss slight. (S-35387.)

GRAND RAPIDS, MICH., SEPT. 20, 1927. BRASS FOUNDRY. Fuel oil for the core oven is supplied by a pump located in the basement. An auxiliary oil supply is provided by a 50-gallon drum piped to feed by gravity. Valves are located in a large pit near the oven. This pit is provided with a drain pipe leading outdoors. Watchman started the fire in the morning and a few hours later returned to cut down the oil supply. In the semi-darkness he apparently operated the wrong valve, allowing the oil to back up slowly into the gravity tank and overflow into the pit. Later, passing through another building, the watchman saw fire in the street as a result of the burning oil draining from the core oven pit. He sounded the alarm and then shut off the supply. Three sprinklers operated and extinguished the fire. The oil in the street was burning fiercely when the public fire department arrived, but they extinguished it with hose streams. Some of the concrete was spalled, and over a hundred panes of glass were broken. Loss was about $300. (S-43430.)

EAST ST. LOUIS, ILL., OCT. 15, 1922. FOUNDRY. Fuel oil is delivered to the kilns by direct pumping at 100 to 125 lbs. and is atomized mechanically. The burners frequently became clogged. There are three burners at each kiln, so arranged that one can be cleaned without shutting off the others. Employee carelessly disconnected a clogged burner without shutting off the oil, allowing a ½-inch pipe to deliver oil at heavy pressure into the room and on to the roof. Oil was immediately ignited by the other burners. Employee was badly burned, but succeeded in shutting off the flow of oil at a valve and sounded an alarm. Hose streams, foam extinguishers, and sprinklers extinguished the fire. Loss $700. (S-35624.)

Failure of Piping or Fittings.

MONTREAL, P. Q., FEB. 12, 1925. FOUNDRY. Fire was caused by a hole being blown in gasket on oil meter located above a core oven. The valve operated immediately, but oil lines had to empty before fire was extinguished. The oil meter was located directly over oil burner and the oil running out of hole flowed on to burner and ignited. Owing to hand valve to shut burner being in line of fire it could not be shut off until lines had drained. Private

fire department responded and used three foam type and four soda and acid extinguishers. Loss was $600. (S-39089.)

READING, PA. AUTOMOBILE BODY PLANT. At this plant the tempering furnaces were brick set and so arranged that the back burners were only used when extra long material was to be heated, as on the morning of the fire. As the foreman turned on the rear burners he saw a fine spray of oil flowing back against a heavy plank partition built about two feet from the side of the furnace. Before the local valve could be operated, the escaping oil took fire from a burner already alight. Promptly shutting off the oil supply and using chemical extinguishers and hose, the employees soon had the fire extinguished except in the roof, where the fire department had little difficulty in completing the extinguishment. The cause of the trouble was a split union. The globe valve controlling the flow of oil to the burners was bronze and to this was screwed a brass union which in turn held the oil nozzle. The shoulder of the movable part of the union had become split, probably through having too great a strain upon it. Loss $1,000. H-8268.)

DETROIT, MICH., MARCH 19, 1926. MOTOR CAR MANUFACTURING. An endless chain conveyor passes through each of the four non-combustible chassis drying ovens. Assembled chassis are sprayed with paint before entering the oven. Drying is done with hot air heated by passing over radiating sections heated by fuel oil. One battery of heaters is located over the center and one foot above the top of each oven. Both the air and oil lines have a length of metallic hose from the pipe line to each of the burners in each battery, and at each end of the metal hose is a soldered joint making connection from the hose to pipe fitting.

One of the soldered joints is but three inches from each burner. Some previous trouble had been experienced with the solder softening and causing an oil leak, but with an attendant always on duty the trouble was promptly discovered until this day. A soldered joint gave way completely, discharging a stream of oil which immediately took fire. One of the foam tanks arranged to operate automatically over each battery of burners operated promptly and apparently extinguished the fire. Some burning oil, however, reached the top of the oven and passed down through the small spaces between the roof sections. In about ten minutes fire was observed inside the oven.

Drippings in the pans beneath the conveyor, grease on the conveyor chains, and paint on the chassis furnished ample fuel for a hot fire. Five hose streams and three sprinklers were used. Loss was about $9,000. (S-41957.)

Pipes, Valves or Fittings Accidentally Broken.

BURNHAM, PA., FEB. 10, 1927. STEEL WORKS. The main fuel oil supply line into the heat treat building runs overhead along the wall and then branches into three pipes which drop to the furnaces. As the load drawn from one of these furnaces was being picked up by a crane, a piece caught against a branch pipe and broke it. The oil striking the hot metal ignited immediately. The main oil supply was shut off and the fire extinguished with two large hose streams and chemical extinguishers. The pyrometer equipment for the furnace was destroyed, and the heat damaged the steel work and the corrugated iron sides and roof of the building. Loss was $1,116. (S-44788.)

SOUTH MILWAUKEE, WIS., MARCH 27, 1925. MACHINE SHOP. In passing around the furnace in heat treating building, the operator climbed over a pile of loose brick and stepped on the fuel oil pipe, which was about three feet above the floor and poorly supported by a wire from a nail on the wall. The ½-inch supply pipe to the furnace was broken, and the man, drenched with oil, ran out of the building. The fuel oil pumps maintain 55 pounds pressure, and the splashing oil took fire from the nearest burner. Air and oil supplies are not interlocked. The electrician was unable to reach the switch to shut down the fan, so he went to the power house and pulled out the switch on the board. Fire inspector stopped the fuel oil pump at the pump house and drained the pipe. Twenty-seven sprinklers were fused, and two hose streams were used to extinguish the fire. Loss was about $1,400. (S-39826.)

CHESTER, PA., DEC. 19, 1925. SHIPBUILDING. An employee was removing a heat from a small blacksmith's tempering furnace when a brick forming part of the furnace was accidentally pulled free and dropped upon a valve controlling the ¾-inch fuel oil feed. This is said to have broken the feed line and the hot brick ignited the oil, which poured out under about 30 lbs. pressure. There were no automatic cut-off devices, and this oil fed the fire until a man could run outside the building and shut off a valve in the yard on the oil supply line. Feeding on the outpouring oil and the soot covered walls, the fire reached the plank and timber ceiling, through which it burned up into the second floor, used as a laying out shop. Sprinklers operated on the second floor and confined the fire here. Due to the intense heat generated by fire, 440 heads opened up. Loss was about $58,000. (S-43534.)

LOCKPORT, N. Y., FEB. 7, 1927. METAL WORKER. An overhead crane was being used to lift the counterweight in closing the heavy door of a large annealing furnace. The crane hook swung over, struck, and broke a small valve on the fuel oil line. Escaping oil flowed to the floor and ignited from the furnace. A 40-gallon foam tank extinguisher was used, and the main oil supply was shut off. The heat was great enough to buckle a steel column supporting the roof and craneway. Wooden sash and electric power conduit were also destroyed. Loss was between $600 and $700. (S-44257.)

Failure of Shut-off Valve.

CLEVELAND, OHIO, MARCH 17, 1926. METAL WORKER. Carbonizing furnaces are fuel oil fired. The night operator temporarily left the room, during which time the fuse to the air blower supplying air to the burners burned out. The interlocking valve apparently failed to operate, so that unatomized oil must have burned outside the furnaces. The flames got between the asbestos ceiling protection and the plank, burning through to the third floor around the columns and at walls. Two sprinklers operated, and chemical extinguishers were used to extinguish the fire. Loss was about $400. (S-42107.)

EDDYSTONE, PA., NOV. 19, 1925. LOCOMOTIVE WORKS. Shortly after the smith shop had ceased operations for the day, a mild explosion occurred in one of the oil furnaces. The cause of the fire was a leaking control valve at the burners, which permitted oil from an overhead line to drip into the hot furnace. The burning vapors traveled through the air supply line to the fan, where there was probably an accumulation of oil and grease on the supporting platforms. A hose line was used to extinguish the fire. Loss was about $300. (S-41259.)

Storage of Oil.

MERIDEN, CONN., AUG. 11, 1925. METAL WORKER. Watchman started fuel oil burner under spelter melting furnace and left the burner alone to make his rounds. Shortly after he heard an explosion, and returning found the melting furnace in flames, also the frame wall of the building. Instead of telephoning the fire department, the watchman went there to notify them of the fire, thereby losing much valuable time, during which time the fire spread to the floor above by means of the wood sheathing, the sprinklers not being able to reach the fire between the sheathing.

It is thought that the flame at fuel oil burner was extinguished by the presence of water in the oil. The oil which continued to flow was ignited, possibly by the incandescent soot in the furnace, and caused an explosion with resulting fire. The explosion wrecked the vent pipe.

Owner advised that the fuel oil tanks leaked, allowing water to enter. They tried to repair them, but the only solution seemed to be the installation of new tanks and piping underground, which also is believed to have leaked. Water was still to be found in the oil, as was observed by inspector when burner was started. After running about fifteen minutes it appeared to clear up. The fuel oil burner on furnace involved in the fire was a home-made outfit, but was in no way responsible for the fire. Loss was $250. (S-41581.)

SEBRING, OHIO, MAY 2, 1924. POTTERY WORKS. A 20-gallon galvanized tank was installed on a ledge against the side of a heated kiln and was used as a settling tank. It contained about five gallons of water and the balance of its contents was oil, being pumped to burners.

Indications are that the bottom of settling tank melted out and the oil spread over the side of the hot kiln and on the floor. The fuel oil pump continued to run for some time after tank split open, because the man in charge of the kilns was new to the job that night and did not understand the installation. He shut some valves on the burner feed lines, but did not know that he had to shut the pump down.

The oil ignited from the burners of the kiln and flames spread all over the room and into other rooms. The sprinklers appeared to have functioned promptly, but probably helped to spread the burning oil rather than extinguish it. Loss was about $5,000. (S-42878.)

Faulty Carburetion.

CLEVELAND, OHIO, MARCH 13, 1925. METAL WORKER. Fire started in the tempering department. It occurred in a fuel oil fired draw furnace, and may have been caused from poor mixture of oil and air, causing sparks which ignited an accumulation of oily soot on the pipes, wiring, roof supports, etc. Fifty-two sprinklers operated, and three hose streams were used to extinguish the fire. Loss was about $2,500. (S-42916.)

Carbonization of Burner.

CLEVELAND, OHIO, FEB. 26, 1926. STEEL WORKS. The first indication of trouble was received when the entire lower part of an annealing furnace burst into flame. The fuel oil supply was immediately shut off and several workmen attempted to use chemical extinguishers to extinguish the fire, but were unsuccessful. Four sprinklers opened, and the fire department used a chemical stream on the fire.

The fire was caused by the clogging of the fuel oil burner from the carbonizing of the oil, obstructing the air supply and allowing the unatomized oil to continue flowing unburned until the pit underneath had become filled with oil. This ignited when the heat from another burner in the same furnace had produced sufficient gas. Loss was about $200. (S-42066.)

Details and Classification of Causes.

Industrial and Mercantile Occupancy Fires.

CARELESS OPERATION.

Heat and Power Installations. (23 Fires)

—Valve not tightly closed, allowing oil to leak, forming gas, which ignited when pilot came on. (2)

—Improper adjustment of thermostat control. (1)

—Improper adjustment of burner. (1)

—Valve opened with expectation that heat from hot bricks in fire box would ignite fuel. Ignition did not take place and gas formed, which exploded when burner was lighted. (3)

—Damper not sufficiently opened. Fire went out but oil flowed on and flared back when ignited by torch. (1)

—Surplus oil accumulated in fire box ignited when fire was started. (4)

—Oil failed to ignite on action of thermostat and flowed into boiler room, where it was ignited from coal fired boiler. (1)

—Oil overflowed from gravity tank into burner pit, due to carelessness of engineer. (1)

—Burner valve left open by watchman, flooding boiler room with oil. (1)

—Inexperienced fireman failed to adjust faulty burner. (1)

—Tank overflowed while being filled. Oil ran into pit where rubbish fire was burning. (1)

—Engineer working around tank with torch. (1)

—Valve opened too wide and allowed too much oil to flow, overheating heater. (1)

—Probably carelessness. No chance to reach basement to determine. (1)

—Pilot light destroyed by heat and discontinued. Fire was started with waste paper, the heat generated in fire box being depended upon to ignite oil. (1)

—Spark from motor ignited lint collected thereon. (1)

—Employee turned out pilot light and oil sprayed into hot fire box, where it vaporized and exploded. (1)

Process Heaters. (25 Fires)

—Watchman closed air valve too much, allowing oil to drip into pit under core oven, where it ignited. (1)

—Furnace man turned on too much oil, and blast and flames ignited ceiling joists. (1)

—Oil in pit from leaky burner ignited, due to carelessness of employee in not cleaning up oil before lighting burner. (1)

—Repair man failed to shut off oil supply. (5)

—Oil overflowed, due to careless opening of valve on tank. Employees paid no attention to flow of oil, which ran under a coke fired salamander, where it ignited. (1)

—Oil valve opened to force obstruction from burner. Burner was cleared, but large volume of oil shot out and caused flare back, preventing closing of valve. (1)

—Operator delayed in lighting burner and surplus oil accumulated and ignited. (3)

—Oil accumulated due to air valve being left open, and intense fire due to surplus oil overheated the device. (1)

—In adjusting burner, oil escaped into flue and later ignited. (1)

—Furnace tender attempted to tighten a union at burner, which broke. (1)

—Employee not familiar with new burner turned valve wrong way—opening it rather than closing it. (1)

—Employee was tapping pipe to dislodge dirt, when it broke, allowing oil to flow into fire box. (2)

—Oil valve opened instead of air valve and resulting flow of oil ignited by hot furnace. (1)

—Watchman opened wrong valve on auxiliary tank, allowing oil to back up and flow into pit. (1)

—Employee endeavored to stop leak in tank by tightening with plug. Oil, being under pressure, forced plug out, allowing oil to flow out and ignite from red hot rivet. (1)

—New employee didn't understand system. (1)

—Carelessness in lighting—exact cause not given. (1)

—Air valve left open overnight allowed oil to accumulate under burners. (1)

Failure of Oil Pipes or Fittings.

Heat and Power Installations. (11 Fires)

—Leak in piping in front of boiler. (5)

—Obstruction in oil line allowed oil to flow into heated ash pit. (1)

—Leak in flexible brass feed pipe. (1)

—Leak at union of piping and burner. (1)

—Leak in union at pressure gauge. (1)

—Leak in piping due to corrosion at screw joint. (1)

—Fuel oil line broken by earthquake. (1)

Process Heaters. (18 Fires)

—High pressure oil feed pipe burst; allowed oil to fall on hot furnace or forge. (4)

—Hose on oil line became disconnected at burner. Oil ignited by welding torch. (1)

—Hole blown in gasket on oil meter located above core oven. Oil flowed into burner and ignited. (1)

—Hole in tube leading to burner in open body oven allowed surplus oil to ignite, setting fire to interior of unit. (1)

—Leak in joint, caused by strain due to no allowance for expansion, started small smouldering under asbestos packing on oil pipe near oil heater. (1)

—Strainer at fuel oil burner blew out, discharging unatomized oil, causing flare back. (1)

—Soldered joint making connection from metallic hose to pipe line near burner gave way and allowed oil under pressure to escape and ignite from burner. (1)

—Leak in oil line or connection near burner. (4)

—Union in exposed branch of underground fuel oil line broke and released oil, which ignited from furnace. (1)

—Brass union at oil nozzle split and released surplus oil to burner. (1)

—Feed pipe broke off in the thread at one of the fitting joints. (1)

—Flexible coupling became loose, allowing oil to leak into burner. (1)

FEED PIPES, VALVES OR FITTINGS BROKEN BY ACCIDENT.

Process Heaters. (13 Fires)

—Crane used to lift counterweight in closing door of annealing furnace struck and broke valve on fuel oil line. Oil flowed into furnace and ignited. (1)

—Operator climbed over pile of loose brick and stepped on fuel pipe, breaking it. Oil under pressure took fire from burners. (1)

—Brick forming part of furnace dropped on fuel line, breaking it. Oil under pressure was ignited from hot brick. (1)

—Load carried by crane broke fuel oil pipe. Oil striking hot metal was ignited. (2)

—Fuel oil line in body oven was accidentally broken at intersection of $\frac{1}{4}''$ to $\frac{3}{4}''$ line. Oil ignited. (1)

—Employee dropped tray of metal parts he was removing from hardening furnace, splitting oil pipe. (1)

—Elbow on oil supply pipe accidentally broken. Oil under pressure sprayed on hot furnace and ignited. (1)

—Oil pipe broken off by truck load of metal. Oil ignited from burner. (3)
—Oil pipe broken by counterweights of annealing furnace door. Oil ignited from burner. (1)
—Oil pipe broken by steel channel being bent. Oil under pressure shot into air and was ignited by burner. (1)

Back Fire—No Specific Cause.

Heat and Power Installations. (10 Fires)

—Back fire—no specific cause. (10)

Process Heaters. (1 Fire)

—Back fire—no specific cause. (1)

Defective Burner.

Heat and Power Installations. (9 Fires)

—Defective operation of burner. (6)
—Defective or loose adjustment allowed surplus oil to flow out. (2)
—Defective burner allowed congealed oil to drop in lump on fire. (1)

Process Heaters. (1 Fire)

—Faulty fuel oil burner at lead melting pot. (1)

Carbonization at Burner.

Heat and Power Installations. (9 Fires)

—Back fire due to accumulation of carbon at burner. (3)
—Soot in fire box ignited. (1)
—Burner became clogged and allowed oil to flow into pit. (3)
—Accumulation of carbon due to slowly rotating burner caused overflow of oil, which ignited. (1)
—Burner plugged and extinguished, allowing oil to flow out and ignite from second burner. (1)

Process Heaters. (2 Fires)

—Burner clogged from carbonizing of oil obstructing air supply and allowing unatomized oil to flow into pit. (2)

Ignition Devices.

Heat and Power Installations. (9 Fires)

—Tardy ignition of oil at burner. (1)
—Gas pilot failed to function. (1)
—Pilot operated by thermostat failed to ignite oil, which flowed into hot fire box. (1)

—Ignition device failure caused explosion. (1)
—Short circuit. (1)
—Gas pilot went out and oil and gas accumulated. Ignited later from automatic ignition. (1)
—Gas pilot failed to ignite oil, which vaporized and later exploded from contact with gas pilot flame. (1)

Shut-off Valve Failures.

Heat and Power Installations. (10 Fires)

—Automatic valve failed to control flow of oil. (3)
—Automatic valve failed to function. (1)
—Automatic thermostat control failed. (4)
—Leaky valve allowed oil to flow in fire box and pit (2)

Process Heaters. (8 Fires)

—Valve failed to hold when fuel oil line was disconnected. (1)
—Valve gave way and oil spurted into room. (2)
—Handle on valve stem controlling oil supply broke and oil flowed into furnace before supply could be shut off. (1)
—Leaky valve permitted oil to get into air service line. Air line cut off, but pressure generated blew off cap and ignited oil. (1)
—Valve leaked, allowing oil to drip. (2)
—Interlocking valve failed, allowing unatomized oil to burn outside furnace (1)

Oil Storage Systems.

Heat and Power Installations. (5 Fires)

—Leakage due to vent pipe being clogged. (1)
—Loose plug allowed oil to flow into pit. (1)
—Tank exploded from unknown cause. (1)
—Leak in small service tank allowed oil to flow out on to floor. (1)
—Tank burst under pressure generated while filling and let oil flow into basement to boiler pit. (1)

Process Heaters. (4 Fires)

—Tank containing fuel oil under pressure opened up at a seam, and fire at burner jumped back to oil. (1)
—Excess air pressure in tank caused rupture. (1)
—Tank leaked water, which flowed with oil to burner, extinguishing same, allowing oil to flow on and ignite from hot fire box. (1)
—Bottom of settling tank on side of kiln melted out, allowed oil to flow down side of kiln to burner. (1)

Faulty Installations.

Heat and Power Installations. (5 Fires)

—Door of fire box, not properly closed up, allowed back draft to ignite material. (1)

—Valve arranged so as to permit accidental opening and allowed oil to flow in pit and boiler. (1)

—Improper wiring caused short circuit, igniting oil in pit. (1)

—Back fire blew out weak insulating cement used to plug opening under boiler when burner was installed. (1)

—Too small opening in fire box permitted excess carbonization. (1)

Process Heaters. (1 Fire)

—Proper insulation between oven and wood floor not made when burners changed from coal to oil. (1)

Pump or Feed Mechanism.

Heat and Power Installations. (4 Fires)

—Not definitely determined. (1)

—Stoppage of oil flow at burner. (1)

—Short circuit in pump motor. (1)

—Air pressure in system too low, releasing oil. (1)

Process Heaters. (1 Fire)

—Automatic feed system failed. (1)

Faulty Carburetion.

Heat and Power Installations. (2 Fires)

—Flare back of oil on boiler room floor due to improper vaporization. (1)

—Poor combustion of low grade oil caused overflow. (1)

Process Heaters. (3 Fires)

—Sparks, probably due to poor mixture of oil and air, ignited flammable soot and residue. (3)

Poor Housekeeping.

Heat and Power Installations. (1 Fire)

—Fire occurred in oil dust and soot collected between ceiling joists above boiler. (1)

Process Heaters. (1 Fire)

—Sparks from burner ignited waste oil on floor in front of burner around motor oil pump. (1)

Not Determined.

Heat and Power Installations. (9 Fires)
Process Heaters. (5 Fires)

Domestic Oil Burners.

The National Board of Fire Underwriters has made a tabulation of domestic oil burner fires from data furnished by insurance fire patrols and salvage corps throughout the United States. These data appeared in a recent issue of "Safeguarding America from Fire," and are reproduced in part below.

The information has been tabulated, as shown, Table No. 1 being based on the total number of reports received during the period from November, 1925, to April, 1928; while Table No. 2 is based on Table No. 1 and indicates the percentage of fires or occurrences due to each cause. In studying these tables it should be borne in mind that in many cases reports were incomplete as to cause, and that it was necessary to interpret them in the light of information supplied. In others, causes may have been incorrectly reported owing to the investigator's limited knowledge of oil burners and their operation.

A study of the first table yields some interesting information. The oil burner systems reported were about evenly divided between the pump and gravity-feed types, thus indicating no material difference in the degree of inherent hazard between types of feed. Taking the total as a basis, apparently 40 per cent were not installed in accordance with the regulations on Oil Burning Equipment. Forty-eight per cent were of makes listed by the Underwriters' Laboratories, 45 per cent were of makes not listed, 2 per cent were homemade or makeshift arrangements, and in 5 per cent of the cases the name of the burner was not given.

Table No. 2 indicates that the failure of automatic shut-off valves to function, and thus stop the supply of oil, caused the largest number of fires. These failures undoubtedly can be accounted for by the improper design of earlier valves, which did not operate positively. Again, it is highly probable that some of these occurrences were incorrectly reported and that some were due to tampering. As considerable progress has been made in bettering the design of these devices and providing more positive operation, the frequency of failures may be expected to decrease.

As was expected, because of the experience with industrial installations, "loose connections and leaking piping" ranks second as a fire cause in domestic oil burners. This may be attributable to poor workmanship when the piping was installed, vibration over a considerable period, or failure to properly protect piping from mechanical injury. Good original installation, supplemented by periodic inspections by a competent man, go far toward eliminating this cause.

The third cause, "back fires," might well be combined with "imperfect combustion" and "careless operation," because most back fires are due to

Table No. 1

Tabulation of Oil Burner Fires Reported by Insurance Patrols.

Cause	Number due to each cause	Character Installation			Type of Burner				Method of Burner Feed			
		In accord with regulations	Not in accord with regulations	Not indicated	Approved	Not approved	Home made	Not stated	Pump	Gravity	Pressure-air	Not stated
Failure of auto shut-off valve	69	21	27	21	36	30	1	2	23	36	3	7
Carbonization	27	13	10	4	13	14	..	..	11	14	1	1
Defective burner	35	15	9	11	9	17	..	9	12	19	..	4
Loose connections, leaky piping	51	22	18	11	23	27	1	..	32	17	..	2
Poor combustion	13	5	1	7	11	2	0	..	6	6	1	..
Back fire	41	26	10	5	23	15	1	2	23	14	1	3
Absence, or extinguishment of pilot light	21	3	9	9	16	5	..	..	10	9	1	1
Unknown	13	3	7	3	9	4	..	..	9	2	2	..
Overheated furnace or breeching	8	5	2	1	2	4	2	..	4	4	..	..
Improper installation	4	..	3	1	1	3	..	..	1	2	..	1
Dirty flue	14	5	8	1	6	8	..	..	6	7	..	1
Clogged feed pipes	4	2	2	..	2	2	..	..	4	..	..	..
Careless operation	14	4	9	1	5	9	..	..	6	7	..	1
Insufficient draft	3	..	..	3	1	2	..	..	3	..	..	..
Rubber hose to pilot light	2	..	2	..	2	..	..	..	1	1	..	..
Gasoline as floor cleaner ignited by burner	1	..	1	..	1	..	..	..	..	1	..	..
Electricity short circuit	9	1	3	5	8	1	..	..	6	3	..	..
Tank overflow during filling	2	..	2	..	1	1	..	..	1	1	..	..
Water in oil	1	0	1	..	..	1	..	..	..	1	..	..
Improper fuel	3	1	1	1	1	2	..	..	3	..	..	..
Oil in air line	1	..	1	..	..	1	..	..	1	..	..	..
Cracked combustion chamber	4	4	..	..	1	3	..	..	1	3	..	..
Defective pump	3	2	1	..	..	..	..	3	3	..	..	..
Absence of auto shut-off valve	15	14	1	..	6	6	..	3	2	8	..	..

The above tabulation is based on records of 353 fires which have occurred during the period November 1, 1925 - May 8th, 1928. It is *not* a complete record of oil burner fires in patrol territories.

Table No. 2

Per Cent of Fires Due to Each Cause.

Cause	Per Cent
Failure of auto shut-off valve	20
Loose connections and leaky piping	15
Defective oil burner	11
Back fires	12
Carbonization	7
Absence of or extinguishment of pilot light	6
Miscellaneous	6
Careless operation	4
Absence of auto shut-off valve	4
Imperfect combustion	4
Unknown	3
Dirty flues	3
Electric short circuit	3
Overheated furnaces and flues	2

carelessness or ignorance on the part of the operator. On the other hand, many back fires are the direct result of failure of the automatic shut-off to function; the flame is extinguished by a clogged, or carbonized, burner orifice which is finally cleared by the built-up pressure behind it, and if the shut-off valve has failed to check the oil supply, atomized oil is forced into the highly heated combustion chamber, where it accumulates until a sufficient mixture of air is obtained. Ignition is thus delayed and when it does take place, may be accompanied by violence sufficient to force off the furnace door and possibly wreck the furnace.

Another outstanding cause, according to the Table, is "defective burner." As a matter of fact, the fire reports in most cases failed to state how the burner was defective, and in other instances listed the burner as "cracked." Perhaps if full information as to these fires were available it might be found that many were caused in other ways.

The figure given for "carbonization" is of decided interest, in view of the fact that it was formerly the main cause. That only 7 per cent of the fires or occurrences tabulated were due to carbonization indicates the extent to which this trouble has been overcome by improved design and construction.

Fires listed as caused by dirty flues and electric short circuits might well be combined and designated "poor maintenance."

Included under "miscellaneous" are two fires resulting from the overfilling of storage tanks. Except for these two occurrences, none of the fires reported was caused directly or indirectly by gravity or storage tanks, and there is no indication that such tanks were involved by fire due to other causes.

Of the total number of fires or occurrences tabulated, 40 per cent occasioned no loss, 24 per cent did not state the amount of loss, 14 per cent caused small fire and smoke losses, 13 per cent small smoke losses, and 9 per cent

small fire losses. Of the total number of fires or occurrences resulting in given losses (36 per cent of the total number of fires or occurrences tabulated), 42 per cent involved losses of $100 or less, 34 per cent more than $100 but not in excess of $500, 9 per cent more than $500 but not in excess of $1,000, and 15 per cent more than $1,000. The largest single losses were $15,000, $12,000, and $6,000.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Gas Stoves.

L-250. SWAMPSCOTT, MASS., APRIL 16, 1928. An aged woman died from burns received six weeks before, when her sleeve caught fire from the flame of a gas range. The flames spread rapidly and although she rolled herself in a blanket and managed to extinguish them, she was burned so severely that she died.

L-255. LYNN, MASS., APRIL 17, 1928. A little girl was toasting bread on a gas stove in the kitchen when her clothing caught fire. Her mother, who was in the yard, heard her screams and rushed into the kitchen. She wrapped some coats about the child and succeeded in extinguishing the flames, but not before she was fatally burned.

Gasoline and Kerosene.

L-257. HAVERHILL, MASS., APRIL 21, 1928. Two small children, preparing breakfast on a kerosene stove, were severely burned in an explosion. In order to get the stove started it was necessary to prime it with gasoline through a small hole in front of the stove provided for the purpose. There is a "gun" provided for the priming, but the children did not have it and were pouring the gasoline from a gallon can with a spout. The burner had evidently been ignited with a match and when the gasoline was being poured through the small hole some spilled over and a flash of flame swept in front of the children. The can in the hands of the girl exploded and both children were enveloped in flames. The boy rushed into his father's bedroom and he succeeded in extinguishing the flames with a quilt. The father then went in search of the little girl and saw her just running out of the door. He wrapped her in the quilt and extinguished the flames, but not until after she was fatally burned.

L-244. CARIBOU, MAINE, APRIL 3, 1928. A woman was using kerosene to hasten the fire in the kitchen stove when an explosion occurred. She was so badly burned that she died in the hospital as a result of her burns. Her husband was burned about the hands as he carried his wife from the house.

L-251. ANDOVER, S. D., APRIL 17, 1928. An aged man died from burns he received when he poured kerosene into a stove. There were evidently some glowing coals in the stove and an explosion resulted. His clothes caught fire and he rushed from the building. The flames were extinguished, but not before he was burned so badly that he died a few days later.

L-254. PRESQUE ISLE, MAINE, APRIL 18, 1928. Three children were burned to death, another was in a critical condition, and their mother severely burned when their home was destroyed by fire. The father had built a fire in the kitchen stove and left the house. It is thought he used gasoline on the kitchen stove in place of kerosene and the fire followed.

Lightning.

H-25811. ATLANTIC CITY, N. J., MARCH 30, 1928. Three children were sitting on the floor in front of the radio listening to a program. It had been lightning for some little time when suddenly there was a blinding flash. The lightning struck the aerial and continued its course to the radio set in the living room. The flash ignited the clothing of the three children, and when their parents reached them one of them lay dead on the floor. His body was a mass of burns.

Tenement House Fire.

H-26019. BROOKLYN, N. Y., APRIL 24, 1928. Two women and two girls were killed when a fire spread rapidly through a four-story frame tenement house. The four who lost their lives in the fire died from injuries received in jumping from the third story windows, after their escape was cut off. The fire evidently started in the hallway and spread rapidly up the wooden stairs and through the partitions. There were sixteen families in the house and the majority of these were asleep when the fire broke out.

Trapped in Burning Building.

L-252. ALTOONA, PA., APRIL 16, 1928. Thirteen people were burned to death when a fire destroyed their two-story frame house. The party had all been guests at the wedding of a daughter of the family and the bride and groom were among those who lost their lives. It is believed that all were asleep when the fire started and that they did not hear the cries of the father, who was awakened by the smoke and managed to make his escape. The cause of the fire is unknown.

Gasoline Explosions.

H-26123. DOUGLAS, ARIZ., MAY 30, 1928. An army air officer was burned to death when he made a forced landing near here. As the airplane struck the ground it was overturned and the gas tank exploded. The machine caught fire and before he could free himself from a life belt he was caught in the blaze.

L-264. GREGORY, S. D., MAY 9, 1928. A twelve-year-old lad was believed to have been experimenting with an old gasoline engine from a washing

machine. He fitted a piece of scrap iron to the shaft for a crank and was trying to start it. He removed the spark plug, turned it upside down and filled it with gasoline. Still holding it in this position with a pair of pliers he turned the crank and the spark exploded the gasoline, setting fire to his clothes. He was severely burned about the body, but death was primarily due to fumes of gasoline inhaled while fighting the flames.

H-26198. MEDFORD, MASS., JUNE 22, 1928. An explosion occurred in a battery and service station which resulted in the death of one man and slight injuries to another. The employee who lost his life was in a room in the rear of the building and the fire spread so rapidly that he had no chance to escape. The exact cause of the explosion is not known.

Gas Explosions.

H-25825. WHITE PLAINS, N. Y., APRIL 2, 1928. One man was burned to death and three others severely injured when their automobile crashed through a barricade and broke a temporary gas main at the side of the road. The occupants of the machine were trapped in the car, which burst into flames when the gas was ignited at the hot exhaust pipe.

H-25993. GRAND RAPIDS, MICH., APRIL 7, 1928. An explosion occurred in the booster plant of the gas works while repairs were being made. Although there has been no definite cause given for the explosion, it is thought that the ignition of the explosive mixture in the mains may have been the result of pouring the hot lead in a joint, which in turn may have charred the yarn, producing a live spark; or the heat of the lead transmitted through the cast iron pipe may have been sufficient for ignition. The man in charge of the regulating valves was either killed by the explosion or stunned, and later burned to death. The men on the repair crew suffered burns of various degrees, and one man has since died as a result of the disaster.

Motion Picture Film.

H-26137. CHICAGO, ILL., APRIL 21, 1928. A four-year-old girl was fatally burned, and her six-year-old brother and another little boy were seriously burned, when their clothing caught fire while they were playing with a roll of motion picture film in the basement of the apartment where one of the children lived. None of the children were able to tell how the film became ignited.

Flash Fire.

H-25782. MILWAUKEE, WIS., MARCH 16, 1928. A flash fire of dry sewage caused the death of one man and burned three others at a municipal sewage plant. The accident happened in the dryer house, where the four men were working to eliminate the dust explosion hazard. Four of a battery of seven drying furnaces had been charged to minimize the danger of dust and the men were working on the fifth. There did not seem to be any explosion but just a quick flash of fire through the dry powdered sewage.